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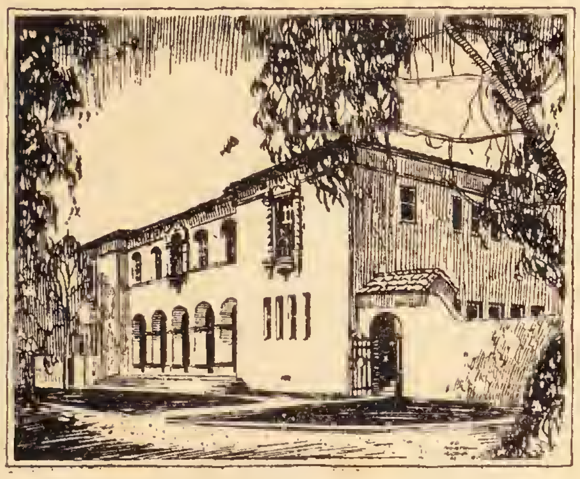
CHARLES E. SHAW

No. 14

Studies of Reptile Life in the Arid Southwest

By L. M. KLAUBER

Consulting Curator of Reptiles, Zoological Society of San Diego



SAN DIEGO, CALIFORNIA

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6. To operate a society for the mutual benefit of its members for non-lucrative purposes.

BULLETINS

OF THE

ZOOLOGICAL SOCIETY OF SAN DIEGO

No. 14

STUDIES OF REPTILE LIFE IN THE ARID SOUTHWEST

PART I.

NIGHT COLLECTING ON THE DESERT WITH ECOLOGICAL STATISTICS

PART II.

SPECULATIONS ON PROTECTIVE COLORATION AND PROTECTIVE REFLECTIVITY

PART III.

NOTES ON SOME LIZARDS OF THE SOUTHWESTERN UNITED STATES

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SAN DIEGO, CALIFORNIA
FEBRUARY 24, 1939

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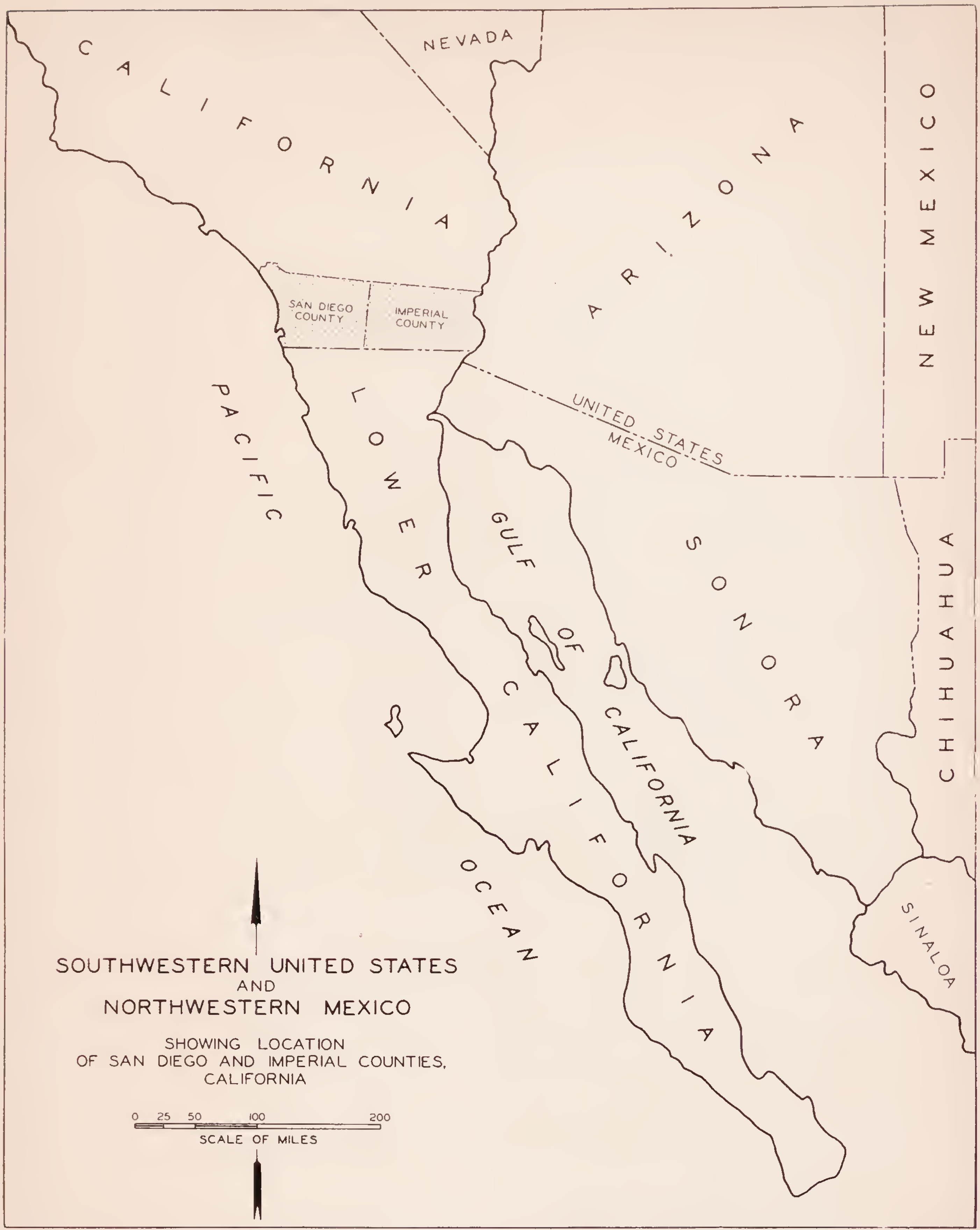

SOUTHWESTERN UNITED STATES
AND
NORTHWESTERN MEXICO

SHOWING LOCATION
OF SAN DIEGO AND IMPERIAL COUNTIES,
CALIFORNIA

PART I.

NIGHT COLLECTING ON THE DESERT WITH ECOLOGICAL STATISTICS

INTRODUCTION

I have discussed elsewhere some results of the development of the motor car and the extension of good roads in their effects on herpetological collecting.* The consequent ease of access to remote territories and the number of specimens found run over on the road which are still in a condition satisfactory for study, have greatly improved the character and scope of our collections, and our knowledge of reptile ranges. It is but natural that the use of the motor car has been extended to a particular phase of this kind of collecting, namely, the hunting of nocturnal species in desert or semi-desert areas by driving slowly along the roads, picking up the snakes and lizards which are crossing, as they are disclosed by the headlights of the car. This scheme has now been so thoroughly tried out, and its effect on our knowledge of southwestern reptiles has been so considerable, that a description of the practice and some of its results should be of interest to those who may find an opportunity to experiment in desert territories where it has not yet been tried.

METHODS USED IN NOCTURNAL DESERT COLLECTING

Historical

Herpetological night-collecting, as such, is not in any way novel. The use of lamps in securing nocturnal species in the tropics and elsewhere has been often described; and in our nearctic herpetological field the hunting of amphibians at night has probably exceeded diurnal collecting, for these animals are most active at night. Furthermore the night-collector is guided by the calls of frogs and toads, and they are more easily caught when they are light-struck by a beam from his lamp. It was natural to extend this kind of night-hunting afoot to searches for the nocturnal reptiles of the desert, and such collecting has been carried on with a moderate degree of success. However, my experience with both methods, that is, afoot and by auto, leads me to conclude there is no comparison between the results of the two schemes, the motor car being both easier and far more fruitful.

Night-collecting by motoring on desert roads, has been so natural and logical a development that no single person can claim credit for its discovery.

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*A Statistical Survey of the Snakes of the Southern Border of California. Bulletins Zool. Soc. of San Diego, No. 8, pp. 1-93, 1931 at p. 53.

Any one interested in reptiles who found it necessary to drive at night on the desert to reach some specific destination, could not fail to notice the snakes crossing the road as they were picked out by the lights of the car; for these light-colored desert reptiles are quite conspicuous against the background of a dark pavement. Similarly, any naturalist who had made a practice of adding to available locality records by listing the specimens found in the daytime run over on the road, must have observed the surprising number of individuals thus disclosed, of nocturnal species hitherto thought extremely rare. Inevitably he would conclude that they must have been run over during the previous night, and therefore by driving at night it should be possible to catch them on the road alive. Thus, a number of us who collect in our southwestern deserts became aware of the effectiveness of this procedure somewhat more than ten years ago and were soon using it rather regularly. Since that time our hunting technique has steadily improved, and concurrently the mileage of roads suitable for this kind of collecting has been greatly extended.

As to my own experience, while I had given some thought to hunting for desert snakes by roaming the roads in a car as early as 1924, when the first DOR* *Phyllorhynchus* (leaf-nosed snake) was found (this was the second specimen to have been reported from California), it was not until 1927 that we were taking night drives primarily to look for snakes. Even then the possibilities were not fully appreciated and we usually got out and hunted afoot with flashlights as soon as appropriate territory was reached. The desert roads in southeastern California were then few and mostly unpaved; only the trunk highways, US 80 and US 99, were surfaced, and these, in the desert area close to San Diego County, do not pass through particularly productive country. However, we had some success with night drives on these roads in 1928 and 1929. In the spring of the latter year I was again stimulated by finding three DOR specimens of *Phyllorhynchus* one morning within a few miles of Oasis, Riverside County. It is difficult to look back now, when this genus has been shown by the new technique to be the most plentiful snake in many desert areas in the southwest, and appreciate what a thrill these three specimens caused then. Anyway it was from that time that the possibilities of the new scheme, as an aid to field study and collecting, were fully realized. Thenceforth our trips were better planned to take advantage of the evenings, and our methods gradually improved. Walking was practically abandoned in favor of driving.

The paved highway from Scissors Crossing, San Diego County, eastward to Benson's Dry Lake (Ocotillo), via Sentenac Canyon, Yaqui Well, and The Narrows, an ideal highway from every standpoint of character of construction and bordering area, was not completed until 1931; since then it has been almost a field laboratory, so frequently have we hunted along its twenty odd miles. During the same period many other branch and secondary highways have been surfaced in the southwestern desert area, and there are now thousands of miles of roads which can be profitably used as herpetological hunting grounds. Thus, the possible scope of this type of collecting has been greatly expanded in our locality. No doubt similar conditions exist in other desert areas, where the same methods may be profitably employed.

---

*Dead on the road.

Physical Character of the Road

Not all desert roads are equally suitable for night collecting by auto. First, for the best results, the road should be paved or surfaced, preferably with some asphaltic compound having a dark color, such as the types known as bituminous concrete, oiled gravel, desert mix, etc. The snakes are more conspicuous on such a background than on a light-colored portland concrete surface. However, even a cement road will often prove quite satisfactory, especially after it has become discolored by lubricating oil. At any rate, a surfaced, as compared to an unpaved road, is much to be preferred, since an unsurfaced road is usually so rough that the shadows of ruts and corrugations make it difficult to perceive the quarry. Also, the color contrast between the road and the reptiles is not nearly so striking as on a dark paved road; and the dust raised may interfere with visibility if there be a following wind.

There is much difference in quality even amongst surfaced roads, not only because of the relative abundance or scarcity of reptiles living along the borders, but also by reason of the type of construction and the use to which the road is put. Trunk highways or heavily traveled roads should be avoided, since they have several objectionable features. First, the lights of machines proceeding in the opposite direction render it difficult, if not impossible, to see specimens. Secondly, on such roads there is an actual danger in driving slowly, and still more in stopping suddenly. Third, it will often be found that on these main highways the heavy traffic has already caused the decimation of the animals living along its borders, as well as the destruction of their food supply. Even though it may be presumed that there is a continuous migration into the fringes of this fatal strip, the total number of specimens available will be decidedly below that to be expected in virgin territory.

Heavily traveled roads are not infrequently littered with debris, which often causes fruitless stops. One of the most unhappy experiences of the night collector is to trail a hay truck which is continually dropping light colored straws, for it is surprising how like small snakes some of these may appear in the glare of the headlights, especially when they are drifting slowly along in the wind.

Another objection to heavily traveled roads has to do with their design, for they are likely to be too well built. In desert territory major highways are often raised on dikes as a protection against washouts from cloudbursts, with deep side-ditches to divert the rare floods through large culverts. The rights-of-way are usually cleared of brush, cactus, and large stones over their full widths. All such conditions tend to interfere with the natural progress of the reptiles across the road, and even to discourage their presence in the vicinity. For the best collecting one should seek a highway surfaced flush with the surrounding terrain, with little or no special grading or side clearing, and in which the shoulders or berms merge directly into the surrounding sand, rocks, or vegetation. It is probable that snakes have little hesitation in crossing such a highway, which appears to them merely as a gap in the surrounding cover.

The nature of the berm itself is of importance. Well-packed oiled berms are preferable to unsurfaced shoulders because of the better contrast of the snakes against the background; also earth is less likely to be brushed onto the pavement itself, thus lightening its color. In some areas, where there are unoiled shoulders, ant hills in them are troublesome, since from a lateral view, they look quite like snakes. However a shoulder which is freshly oiled undoubtedly prevents many specimens from crossing. A narrow road with no berm at all is not satisfactory for two reasons: first, the lack of a suitable turn-out makes stopping for specimens somewhat hazardous; and secondly, the absence of a shoulder upon which snakes can be observed decreases the total area of the territory inspected.

A road with an occasional curve of long radius is to be preferred to one with exceedingly long tangents, since the lights of oncoming cars will be objectionable in the latter case, even though the traffic be infrequent; but roads with many sharp curves make poor hunting grounds, as they require too close attention from the driver to permit a proper inspection of the shoulders; and, besides, stopping for specimens is dangerous.

Roads bordering railroads or canals are usually relatively barren. Cultivation and irrigation often change the character of the contiguous reptile fauna, but do not necessarily decrease it.

A preliminary daytime survey of the area to be covered at night is desirable whenever possible. It is not easy to gain a good idea of the physical character of a road and the nature of its borders in darkness; and one will often find by a re-survey in the daytime that he has been wasting his time on a road or in a country rather unsuited to this type of collecting. One can often determine by a daylight reconnaissance and by the presence or absence of DOR specimens—especially in the early morning before the birds have picked them up—whether he is in a fruitful area and the season is propitious. I have been told by collectors who restrict their operations to localities with which they are thoroughly acquainted, that they usually postpone their activities until the presence of many DOR snakes indicates that the collecting season has arrived. However, a word of caution on this point: do not expect DOR specimens on an almost untraveled road; learn to correlate the specimens with the density of traffic, for DORs result from the coincidence of both snakes and autos.

When either a daylight survey or night experiences have shown a particular section of highway to yield a good catch, a collector will do well to shuttle back and forth as long as he wishes to secure the species occurring there. Snakes are not equally distributed throughout desert areas. As might be expected, some prefer boulder strewn sections, some sand, some brush and cacti. Extreme barrenness is definitely unfavorable. Because these features are not visible at night we are likely to wonder at differences in catches which a daylight exploration would have readily explained.

TIME AND SEASON

The experienced collector in the southwest will do his diurnal lizard hunting in the morning, the time of starting depending on the season and temperature. He will do his fast traveling between collecting stations in the afternoon, when reptiles are usually inactive. The evening excursion of the type here discussed should start about sundown or a little before. At this time gopher snakes, red racers, patch-nosed snakes, and similar diurnal or crepuscular species are likely to be abroad; and the lizards are seen again, although not to the same extent as in the morning. As the dusk approaches, the nocturnal reptiles begin their activities and the regular night-hunt is on. How late one should stay out will depend upon his own endurance, the season, and the temperature. In the spring the reptiles are most active in the early evening before the chill of night has settled on the desert. As summer advances the temperatures of the air and ground surface remain so high in the first evening hours that the greatest activity may be expected later, possibly at the time of minimum temperature just before dawn. The date of the emergence from hibernation varies in different sections of the desert, being affected by altitude, wind exposure, and similar conditions which modify the temperatures of air and ground. Furthermore, the season may be changed from year to year by such causes as produce an early or a late spring. This matter of relative activity and the factors affecting it will be discussed more fully in citing the results of our experiences.

For those who do not wish to camp on the desert, suitable accommodations should be sought before starting out on the evening ride. It is well known that auto-camps fill up rapidly in the early evening, and the late traveler is likely to find himself without a lodging. Even where vacancies are still available, it is undesirable to chance finding a satisfactory camp late at night.

SPEED

The speed at which one drives in a collecting expedition of this kind may vary from 10 or 15 miles per hour up. A rate of between 15 and 25 miles an hour, depending somewhat on the character of the road and the frequency of specimens, will probably produce the best results. We have two somewhat conflicting alternatives from which to choose; with a slow speed fewer specimens will be lost by being unobserved (particularly on the berms), and fewer will escape, since one can nearly always stop the car before they are reached and thus the quarry can be kept within the headlight-illuminated area. On the other hand, with a higher speed, more ground will be covered, and therefore more specimens should be seen, since the number of individuals disclosed is a function of the area inspected. But too great a speed will surely result in many specimens being overlooked entirely, while others will escape, since the car will be driven some distance past them, and often they will get off the road and escape into the surrounding cover before one can back up and catch them. Also a higher speed means less certainty in diagnosing objects which may or may not be reptiles, and therefore results in more fruitless stops.

Of course if one is combining collecting with a desire to reach a distant destination at a given time, a relatively high speed may be necessary, and a desert trip will not be entirely barren of results even at 50 or 60 miles an hour. However, under such conditions some of the small snakes, especially those on the shoulders, are sure to be overlooked; and a few will escape before the car can be stopped, although most snakes do not move particularly fast across the roads at night.

Where the drive is purely for collecting purposes and not with the dual idea of securing specimens and reaching some particular destination, I have stated that a speed of about twenty miles an hour is most desirable. It is obvious that if you propose to cover a road but once, instead of shuttling, then the slower the speed, the more specimens seen; for time, rather than distance, becomes the variable element.

SEEING AND CATCHING SPECIMENS

As the snakes on the highway at night are viewed at a rather sharp angle, the lateral colors are of more importance than the dorsal markings in affecting visibility. Most of the desert snakes are light-colored, especially on the sides, this being notable in such species as *Arizona elegans occidentalis, Sonora occipitalis, Chilomeniscus cinctus, Phyllorhynchus decurtatus perkinsi,* and *Crotalus cerastes.** However, even the darker species, such as *Rhinocheilus lecontei* and *Crotalus scutulatus* are sufficiently light on the sides so that they appear quite conspicuous against a black road surface. In fact, at a distance it is somewhat difficult to tell a light-colored from a dark-colored snake in the beam of the headlights, so clearly are they all visible. Specimens are somewhat more readily seen on moonless nights than in bright moonlight.

If one is interested only in the live snakes and is willing to forego the DORs, he will make fewer fruitless stops, because the live snakes have a peculiar and characteristic appearance best described as "crinkly," which serves to distinguish them from other objects on the road. However, this is only true when they are outstretched in a normal crawling position; snakes will occasionally assume a resting coil on the road to enjoy the pavement warmth, and in such a case they may be confused with other objects. And the very small snakes are difficult to be certain of, even when crawling. The DORs, often useful for museum collections, are less easily recognized, especially if flattened by traffic. Fortunately for the collector, they sometimes succeed in writhing onto the berm before they finally die, and thus escape being pounded to pieces. Snakes which die in the center of a traffic lane are sometimes only slightly cut.

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*Those who are unfamiliar with the technical names of reptiles will find common names ascribed to most of the snakes discussed in this paper in Table 1, p. 38, and the corresponding names of the lizards in the Table of Contents, p. 5. The use of the technical or scientific names is not, as many seem to think, an academic affectation; unfortunately, for those who don't like them, it is only by their use that definiteness, in referring to a particular animal, can be secured. This is because there is no system or authority in assigning common or popular names. The term, "striped ground snake" may refer to one snake in California, and to an entirely different snake in Utah, where the Californian's "striped ground snake" may be called a "banded burrowing snake." And even in California the "striped ground snake" may have half a dozen different names in as many different localities, all of which may be used with equal authority, for there is no ultimate authority to decide between these appellations. But there is a set of international rules governing the assigning of technical names, which gives them definiteness, precision, and general acceptance. And if the application of the rules occasionally renders a change necessary, the change likewise is generally accepted and adopted by those familiar with the rules.

If you see something questionable on the road, reach a decision quickly whether or not to stop; and if you do decide to look it over, glance in the rear-vision mirror for safety's sake, and then jam on the brakes. Back up and look the suspect over with your hand flashlight; you need not get out of the car to do this. In the long run you will have fewer regrets by taking a chance on more stops. True, you will stop for many a scorpion, walking-stick insect, or plain ordinary stick; or for a banana peel, bit of rope, or fan belt. But again, you will be rewarded by stopping for a pat of earth that turns out to be a neatly coiled young sidewinder; or a straw which, on closer inspection, is found to be a dead, but virtually unblemished, desert worm snake. This has happened to me enough times to make me willing to sacrifice time and brake-linings. It must be remembered that some of the smaller specimens only a few inches long and of less than pencil thickness, such as the juveniles of the ground snakes and full-grown worm snakes, are rather difficult to see, the latter especially because of their semi-transparency. Yet not infrequently we have collected snakes less than six inches long and ⅛ inch in diameter.

If traveling at high speed, one should have available in the front seat a white cloth tied to a weight. This can be thrown out as the snake is passed, and serves as a marker. Otherwise, when the car has stopped and backed up it is difficult to tell, within a hundred feet or more, where the specimen was actually seen. In this kind of driving keep a wary eye on the rear vision mirror so that a sudden stop will not be made with a rapidly approaching car in the rear. Stops should not be made on blind curves. Also, in the excitement of seeing a prospective victim don't forget that a soft shoulder on the desert, if you drive into it, may mean a cessation of activities for the night, unless some philanthropist happens along with a tow rope.

If there are young persons in the party they will find it quite exciting to sit on the front fenders, from which advanced observation posts they will often spy snakes, especially those on the shoulders, which would otherwise be missed. They also have the advantage of being able to dismount quickly, thus capturing specimens with a minimum chance of escape. It is unsafe to drive over twenty miles per hour with collectors riding the fenders; besides the wind incident to a higher speed makes it impossible to see specimens. This scheme should not be tried on nights of high winds because of the danger from flying sand and pebbles, into which one may drive quite suddenly and unexpectedly.

When hunting on a road on which there is virtually no traffic, it is well to drive in the center to illuminate both berms. It is so easy to see snakes on the crown of a black road, that, if there be two people in the car, each one should watch a shoulder; the center of the road will take care of itself. If there are more than two in the party, the rear seat occupants can watch the berms to advantage.

The condition in which snakes are found on the road at night varies considerably. Sometimes they are moving rapidly as the lights pick them up, at others they are crawling slowly or are still. Occasionally they are coiled and resting, evidently to take advantage of the greater heat storage in the pavement; for in the early evening on nights when the air temperature is below the optimum the pavement surface will be found distinctly warmer to the hand than the earth or sand by the roadside.

Sometimes the snakes seem disturbed by the light; at others they do not attempt to escape until approached by a person on foot. Then their frantic writhing is rather ineffective on the smooth pavement surface and they actually progress rather slowly, probably slower than if they were less violent. *Crotalus cerastes,* with its peculiar method of locomotion, seems to experience the least difficulty on the smooth surface; *Sonora occipitalis* is another species which can make good headway. These sand-dwelling forms are thus aided by their normal experience with a surface on which locomotion is difficult. Probably more specimens of *Sonora occipitalis* escape than any other of our southwestern desert snakes; they are quite likely to move rapidly off the road as soon as they are picked up by the lights.

The gecko *Coleonyx variegatus* seems to differ from the snakes in that it is dazzled by the headlights and will usually remain quiet on the road if the car be stopped quickly enough to keep the beam on it. But if the car is driven past, it will often escape.

While the temperature affects reptile activity it should not be supposed that snakes are always slow and lethargic on cold nights. They are frequently surprisingly active. On April 25, 1932, in southern Nevada, we caught two *Crotalus cerastes* at 7:45 and 8:25 p. m., with a strong, cold wind blowing, and another snake, probably of the same species, escaped. Unfortunately, this was before we started recording temperatures, but I suspect it was well below 60° F. I think the sidewinder, the most highly specialized of our desert snakes, is able to remain active in the face of low temperatures better than any of the others, with the possible exception of *Rhinocheilus lecontei.*

Sometimes the snakes found on the road when the desert is cold do seem lethargic. However, one must be sure that they have not been injured in judging the effect of cold. Occasionally a specimen is picked up which seems to be uninjured, but will be dead the next morning, the result, no doubt, of having been run over by a car, yet showing no external injuries.

But at times it is the cold. On May 28, 1938, I picked up an *Arizona elegans occidentalis* at 10:45 p. m., air temperature 60° F., so stiff and dull that I thought he was a traffic casualty. But the next morning found him quite lively after he was warmed up.

Snakes on the highway generally try to escape in whatever direction is away from an intruder, so that usually they can be herded back toward the center of the highway, where they can be more easily caught. But sometimes they will try to make for cover even if it be toward the intruder. Thus, on one occasion May 2, 1937, I had a sidewinder come directly at me in his best fighting pose. As I stepped out of the way his purpose was clear—he took refuge under the car. This serves as an example of how and why rattlers "attack" people. When you have backed up to catch a snake always look for him under the car if he has disappeared; try to be careful in backing not to run over the snake you seek.

When driving at such a speed that a snake is passed before the car can be brought to a stop, if there is someone along beside the driver, he should make every effort to keep the snake within view by leaning out of the window as the car goes by, training the beam of a hand flash-lamp on the quarry. This should be done even if you throw out a marker. Then if the snake leaves the highway, it will at least be known to which side he has gone, which is of primary importance in finding him.

Always, when you have stopped to pick up a specimen, look ahead in the illuminated area for another, and sometimes you will be rewarded, as I have been on several occasions, in seeing one start across the road at this opportune time. In the same way on our day drives we always glance down each side road passed, thus adding to the total territory inspected.

Our desert reptiles have little or no eye-shine, at least it is so faint as to be of no importance in this kind of collecting; it is not to be compared in brightness with that of a prowling cat, whose eyes may be seen reflecting the headlights at a distance of a couple of hundred feet or more.

COLLECTING EQUIPMENT

It is desirable to have a roomy car, with plenty of space for the material collected and the equipment necessary for the proper preservation of such specimens as may have been run over by other cars. Many of these will be found but slightly damaged, and for a study collection they are just as useful as live specimens. Their preservation constitutes a prevention of waste, although probably not so considered by the buzzards and ravens which patrol the roads in the early morning.

The old-fashioned car with the driver seated well up, permits better observation than a more rakish type which throws the driver down behind the hood, thus obscuring the road for twenty feet or more in front.

At low speed it is preferable to use the city lights, which throw a concentrated beam close to the car. At high speed the country driving lights are necessary, since otherwise the snakes are not likely to be seen until one is almost upon them. Spot-lights on the car, while useful, are not essential, and are banned in some states. Fog lights with yellow lenses, which have recently become popular in California, considerably increase the visibility, and may also be directed slightly outward independent of the regular headlights, thus widening the spread. With both city lights and fog lights on, the road will be quite brilliantly illuminated. Even where the illumination is clear, some stops are to be expected for likely looking objects which, however, do not prove to be reptiles.

Because of the traffic, snakes on the road should be picked up as quickly as possible. No special equipment is required for the non-venomous species, but for the rattlers and other venomous snakes, a large pair of forceps will be found serviceable for the smaller individuals and a regular snakestick for the larger. Hand flashlights should be available for use when a snake gets off the road; in fact, unless the car be stopped with the headlights focused on the quarry, a flashlight is always essential. Never pick up a snake in dim light with bare hands; rattlers look slim in artificial light.

Large specimens may be placed in boxes or muslin bags. For the smaller specimens, jars with perforated metal tops, each containing a little straw or moss are found most useful. These may be carried in the partitioned pasteboard containers in which they are shipped from the factory. Into such jars specimens may be dropped with a minimum of wasted time. With each specimen a paper locality slip should be included; this not only identifies the specimen but shows that the jar is occupied. If the locality is not definitely known the speedometer reading should be recorded on the slip; then by appropriate entries in the log of the trip and from the speedometer mileage, which should always be noted therein at towns, cross-roads, and other features designated on the road-maps, the exact locality of each specimen may subsequently be determined. Adequate road maps are essential.

A good air thermometer should be provided, the readings to be taken by holding it with exposed bulb well out of the car, and above the flow of heated air from the engine. A specially calibrated bath thermometer is suitable, since the wooden sheath prevents breakage. An aneroid barometer is desirable. Plenty of flashlights with spare batteries and lamps should be at hand. A bright ceiling light in the driver's compartment of the car will be found exceedingly useful in handling specimens and keeping records.

All of the supplies and equipment necessary for conserving DOR specimens should be available, such as jars of preservative, scissors, tags, and forceps. These should be readily accessible, to save time in preparing specimens. Even DORs too badly damaged to be worth saving should be identified to add to the locality records. If the pattern has been obliterated the snake should be soaked over night in water; this will usually bring out both pattern and color sufficiently to permit recognition. An examination of DOR specimens with flashlight and scissors sometimes results in interesting food notes.

The data to be recorded with each live specimen are as follows: Speedometer mileage, time, air temperature, wind, and the nature of ground and vegetation to the extent they can be ascertained. These data should be entered in the log-book, which will cross-index to the tag dropped in the container, through the species name and mileage reading. Each evening general observations should be made with respect to the time of sunset and complete darkness, and the state of the moon. If a thorough survey of a territory is planned, including a correlation of the prevalence of reptiles with the time of night, temperature, and season, then temperature readings and observations on the wind should be made at intervals of about 15 minutes, regardless of whether specimens are being caught. I now have cause to regret my failure to keep accurate records on my early trips, at times when specimens were scarce or entirely absent. In some ways it is as interesting to know when they are not out as when they are. Soil temperatures are valuable if there is time for them; also cloudiness and humidity records.

It is impossible accurately to judge the ecological conditions of the territory bordering a road on a dark night, unless frequent stops are made with side excursions afoot to a considerable distance. If it be deemed important to have appropriate data on each specimen collected it is better to return on the following day and make notes correlated with the speedometer readings of the night trip.

The thrill of this collecting lies in the white crinkly appearance of a real snake suddenly coming within the range of the headlights. It is this thrill, and the hope and expectancy that one will be disclosed as the beam picks up the next black patch of road, that causes anyone with a gambling temperament to drive too fast. Also, it brings you out again after many a fruitless night.

FACTORS INVOLVED IN NIGHT COLLECTING

SEASONAL AND CLIMATIC FACTORS

Even after ten years' use of this scheme of collecting and the keeping of records on each live specimen secured, with respect to time, temperature, wind, moon, etc., we still lack conclusive data on many factors of nocturnal activity. That some of these conditions considerably affect the extent of reptile activity, and thus the collector's success, is of course amply evident; but we are not sufficiently sure of them to determine in advance what may be expected on any given night in any specific territory. Our best calculated theories are often refuted by inexplicable results, both good and bad, in previously tested territories when, because of some unknown factor, nights which seem to us quite similar produce totally different results.

In general we believe that the spring is the best time of year for collecting, just as it is the season of maximum activity of the diurnal snakes in the coastal area. However, it seems that nocturnal collecting on the desert probably reaches its peak about two weeks subsequent to that of the diurnal snakes on the coast. On the desert this would be between May 20 and June 10 in a year of normal spring temperatures, subject to local variations based on altitude, wind exposure, etc. At this season also, snakes will be found more active during the early, rather than the late hours of the night.

The optimum temperature (of the air) is thought to be between 80 and 86 deg. F., depending somewhat on the surface and subsurface soil temperatures. However, snakes have been found active at air temperatures as low as 60 degrees, and in fact we have had some satisfactory collecting trips during which the air temperature has varied between 65 and 70 degrees. Very strong breezes in the early evening, which are rather to be expected on the desert in the spring, somewhat reduce the collecting possibilities, yet specimens are occasionally taken under conditions of high winds. Because of its higher altitude, the western Mohave Desert has a later season than the Colorado Desert (the Cahuilla basin), much of which is below sea level.

Summer night-hunts, particularly after June 25, are nearly always disappointing, for there is a marked reduction in activity. Such as there is probably occurs after midnight, when the temperatures of soil and air have reached a more comfortable level. However not all of this summer lethargy can be charged to the temperature, for the same reduction of activity is evident on the coast where temperatures, even in the daytime, rarely reach a point uncomfortably warm for snakes.

In the autumn, after the young of the year have appeared, there is a somewhat increased activity, as compared to the summer, but it seems to be less than that of the spring. A large proportion of the specimens collected in the fall are recently-born (or hatched) young.

As I have stated, it should not be thought that the relative activities in these seasons are entirely dependent on temperature or other transitory conditions. In the spring, which is the mating season and the time of hunger after hibernation, there is likely to be much activity in spite of unfavorable temperatures both of air and soil; while in the summer there is little activity even on cool nights when the temperature is unusually favorable. Hence the spring hunts are generally the most productive; but since this season is climatically variable, a long drive to some distant part of the desert is a gamble at best, for there may be a sudden adverse change while one is en route. But the gamble is to be preferred to hunting later in the season when the weather is more predictable but the snakes are less active. These statements on relative activity are based on many seasons of observation; at present there are few statistics to prove them. I cannot too strongly urge the beginner in this type of collecting not to be discouraged by initial failures, for there are many such, inexplicable on any theory of time of night, temperature, or season.

Attempts to correlate mammal activity with that of the desert snakes have not resulted in anything definite. Sometimes both are active on the same nights. But there have been other times when rats and mice have been extremely abundant while snakes were scarce; the mammals of course are less affected by the weather.

With respect to temperature, it is evident that the ground temperatures must likewise be studied if we are to know the cause of the variability in activity, this being as important as the air temperatures, which we usually record. Thus a high air temperature in the early spring will not bring out the reptiles before the ground temperature has had time to rise. It must be remembered that the nocturnal desert reptiles, being in the seclusion of holes, or under rocks or sand in the daytime, and being close to the ground when active at night, must be strongly affected by surface and subsurface temperatures.

We know relatively little concerning the effect of humidity. In those sections of our southwestern area having summer, rather than winter rainfall, it is stated that the reptiles are more active after the rains. We have not had sufficient experience to determine whether this is true of the nocturnal forms. However, in the vicinity of Tucson we had good luck on one decidedly humid (but not rainy) night in June, while the subsequent nights, which were drier, but similar in other particulars, proved barren.

We judge from our experience that areas which are subject to extreme and almost continuous winds are less apt to afford good collecting than those which are more protected. Thus, the San Gorgonio Pass, in Riverside County—a sort of air funnel through which the winds enter the desert between the San Bernardino and San Jacinto Mountains—is not a particularly good hunting ground, although snakes are by no means absent there. But, coming out of the pass, as one rounds the northeastern shoulder of Mt. San Jacinto and enters the more protected area from Palm Springs southward, the number of specimens found on the road, particularly of small forms such as *Sonora* and *Phyllorhynchus,* increases perceptibly. We have noted the same condition in driving on the aqueduct construction road along the southwestern base of the Little San Bernardino Mountains in Riverside County. More specimens are found on the shielded branch roads up the side canyons than there are on the main road, out where the wind is much stronger. Thus, for example, on May 21, 1938, we secured 6 live snakes on the branch roads up the canyons, but we got only one along the main road connecting the branches. There was a strong, cool wind sweeping this road, while the branches were quiet and protected.

This is probably one of the advantages of the Borego area is eastern San Diego County, which we have found so fruitful, since it is partly protected by the Cuyamaca Mountains. On the other hand, these territories at the foot of the mountains have one disadvantage in the spring, in that there may be winds, sweeping down from the snow-capped peaks, which are quite cold; and thus the temperature close in to the foothills is likely to be 10 to 15 degrees below that of the areas farther out on the flats.

It is quite conceivable that the sand storms experienced on the desert in the spring would be fatal to small snakes, should they be unsuccessful in securing an immediate refuge. Not that they would be buried, for they are nearly all burrowers upon occasion and could no doubt extricate themselves. But these winds are very strong, and in some areas, particularly in the sandy washes, mixtures of sand and pebbles are hurled through the air with such velocity that the windows of a car may be sand-blasted and pitted beyond use within a few seconds. While I have found many snakes out at night in heavy winds, I have never come upon them at a time or in a place where sand or stones were flying. In the sand hills themselves, in a moderate wind, the sand drives in sheets rather close to the ground—say from 18 inches to 2 feet high—and thus, while it renders the road almost invisible, it is not particularly hard on the car, nor do I think it would be dangerous to reptile life. But these dunes are of relatively fine sand; where the sand has been unclassified by nature the effect may be much more serious.

It is the general feeling amongst those experienced in night collecting that the dark of the moon is better than a half or full moon; but we cannot be sure of this, since there are so many other complicating factors which must be eliminated before a single factor can be correlated with the results. We only know that on some nights, when all conditions have appeared adverse and we have gone out rather hopelessly, yet have persevered only because of having come a long way to collect, we have been unexpectedly gratified by the results. On other nights, in territory known to be well supplied with snakes, and at a time when seasonal and climatic conditions appeared ideal, nothing whatever has been secured. There is no guarantee of success on any one trip in this scheme of night collecting; it is only in the aggregate that results can be counted on.

ENVIRONMENTAL FACTORS

This method of collecting is thought to be of value primarily in desert or semidesert areas. Genera or species normally nocturnal such as, in our southwestern area, *Sonora, Phyllorhynchus, Chilomeniscus, Hypsiglena,* and *Crotalus cerastes* must predominate; or the climate must be such as to have forced an essentially nocturnal existence, during the spring period of maximum activity, on forms which elsewhere, at a corresponding season, are diurnal or crepuscular, e.g. *Lichanura, Lampropeltis,* and *Crotalus ruber.*

Night collecting in southern California has never been successful in the coastal areas, although there are some forms there which are solely nocturnal, such as *Arizona, Trimorphodon,* and *Tantilla.* Also in the foothills many of the species which are diurnal in the spring must be nocturnal during the hot summers to whatever extent they are then active. The fact that these snakes are occasionally out at night is shown by the presence of fresh DOR specimens in the morning. However in coastal southern California most of the species are diurnal during their spring period of maximum activity, which is, after all, the principal collecting season. On the whole the snakes active at night in the coastal areas are decidedly fewer, both proportionately and numerically, than on the desert, and their darker colors render them less conspicuous. As a result the best hunting on the coast is the daylight hunting, while on the desert the night is unquestionably to be preferred. I have traveled at least thirty thousand miles on business in the coastal areas of California at night, and during some fifteen years I have seen only three snakes crossing the road after 8:00 o'clock, two of these being *Lampropeltis getulus californiae* (ringed phase), the other *Pituophis catenifer catenifer.* Of course I was not hunting for snakes, except on a few occasions, and some may have been missed; but certainly no large specimens could have been overlooked. In contrast several hundreds have been caught at night on the desert.

Comparing diurnal coastal collecting at the peak of the season with nocturnal desert collecting, there is no question but that the latter, under average conditions, will yield far more specimens. I do not consider this due to a greater snake population in the desert, but rather the result of a more dense cover of vegetation on the coast, and the additional fact that the diurnal snakes on the coast show themselves less frequently in the open, even in their spring period of maximum activity, than do the nocturnal snakes at night on the desert. Evidently predators are a less serious problem for the latter to withstand.

Diadophis amabilis similis is the nearest counterpart on the coast to the abundant little desert snakes, *Sonora occipitalis* and *Phyllorhynchus d. perkinsi.* But the ring-neck, although plentiful in San Diego gardens, is not as often found roaming in the open, either in the day or night, as are the desert snakes at night; most of the ring-necks are discovered under garden trash. But on the desert, even the forms previously thought to be almost exclusively subterranean, such as *Leptotyphlops,* are found to be active on the surface at night, and are frequently captured on the roads by the new technique.

As to the ecological conditions on the desert itself, one must expect a considerable variability. Areas virtually barren of all vegetation are likely to prove poor collecting grounds, although even drifting sand dunes may harbor *Chilomeniscus cinctus* and *Crotalus cerastes.* But, in general, snakes are more plentiful where there is a considerable vegetative cover. For example: just east of Ocotillo, near the San Diego-Imperial County border, there is a rather sudden decline in the density of vegetation. Plants become both smaller and more widely spaced. Many trips through this area have indicated a corresponding falling off in the reptiles. Along the eastern border of the Salton Sea there is a very barren territory and reptiles are exceedingly scarce. The same is true of dry lakes where the alkali has curtailed vegetation. Alluvial fans, even where well covered with plants, are usually poor collecting areas.

Rocky sections, especially where there are large boulders, are likely to afford good collecting and are of particular interest because they harbor certain species rarely found eleswhere, such as *Trimorphodon, Tantilla, Hypsiglena, Leptotyphlops,* and *Crotalus mitchellii pyrrhus* or *C. m. stephensi.* The cuts of mountain roads are sometimes fruitful stretches. Fills, on the contrary, are poor, just as are the dikes on the flats.

There is evidence that snakes are more quickly exterminated by roadside casualties in areas where the vegetation is light than in places where it is more dense. It is presumed that they have more or less regular hunting routes, and where the vegetation is sparse they range farther than where it is thicker. Obviously, the greater their prowling area the more likely they are to cross a road and thus become DORs. Desert forms accustomed to sparse vegetation seem less afraid to cross an open road than the coastal snakes which are used to the more dense protection of chaparral.

Irrigated areas, in what were once desert territories (e.g. the Imperial Valley), present interesting contrasts with what the reptile fauna probably was in pre-irrigation days, to judge from the present situation in contiguous unimproved areas. Certain species are much more common in the irrigated areas than in the dry sections; especially is this true of *Pituophis catenifer deserticola* and *Coluber flagellum frenatum. Arizona elegans occidentalis* and *Salvadora grahamiae hexalepis* seem little affected by irrigation, although somewhat more prevalent within than outside such an area. These are species which frequent both Upper, as well as Lower Sonoran Zonal areas, or have related subspecies there. But the extreme desert forms, such as *Phyllorhynchus decurtatus perkinsi*, *Sonora occipitalis,* and *Crotalus cerastes,* are undoubtedly affected adversely; they virtually disappear when the land is put under irrigation; if found at all they are on roads bordering dry and neglected ranches. To supplant them a new river-bank fauna moves in, following the irrigation ditches from their river sources. Such species, in Imperial County are *Lampropeltis getulus yumensis, Thamnophis marcianus*, and *Sonora miniata linearis.** If present at all in pre-irrigation Imperial Valley these three species must have been scarce. Similar situations exist in other reclamation areas.

COLLECTING EXPERIENCES AND RESULTS

SUMMARY

What are the results achieved by this form of collecting? Of course, fundamentally it has improved our collections. It has resulted in the taking of many specimens of forms previously considered extremely rare, which before were only secured in fortuitous ways; in plowing, grading, or excavating; or in the laborious overturning of rocks and debris. Night driving has afforded us a better knowledge of the ecology of these species—the character of the ground and vegetation where they live. Much more is known concerning their exact ranges, both topographical and territorial; of their habits at night, and, to some extent at least, their reactions to temperature changes.

I wish now to cite some of our southwestern desert experiences, to illustrate the general effects on reptile populations of the climatic and environmental factors which have been mentioned, and to outline some of the observations made on particular species. This is done by presenting the results of example hunting trips, rather than exclusively in the form of statistical tables, as such trips are more interesting and to the point. The tables have not been neglected, but are reserved for a subsequent section, wherein individual species as well as general considerations of reptile habits are discussed.

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*Formerly referred to *S. episcopa.*

DRIVING COMPARED WITH HUNTING AFOOT

I wish to offer first some comparisons between hunting afoot and driving. On April 30, 1927, six hunters, all equipped with flashlights, or gasoline pressure lamps, in about three hours work on foot amongst mesquite hummocks near the old Borego Hotel, secured three *Sonora occipitalis* and one *Coleonyx variegatus.* There were no good roads in that area then, but a comparison with recent typical results in the same vicinity indicates that the relatively hard work of hunting afoot was poorly repaid. On another occasion (June 25, 1938) a skilled reptile hunter roamed the desert in a good area near The Narrows from 8:10 until 10:00 P.M. He secured 3 *Coleonyx* but no snakes. During the same time and in the same section one car picked up 7 live snakes (*Phyllorhynchus* and *Arizona*) and 2 *Coleonyx*, while another car secured 3 snakes.

Possibly the best comparison between the two types of hunting is furnished by the following: A hunter of experience and perseverance, collecting afoot in the Borego area for two weeks in mid-May (during which time he went out almost every night for several hours), secured a total of 6 *Sonora occipitalis*, 4 *Crotalus cerastes*, 1 *Phyllorhynchus decurtatus perkinsi*, 1 *Arizona elegans occidentalis*, and 1 *Rhinocheilus lecontei.* That was considered a fine catch in those days of ten years ago. Today we expect to get about as many snakes in a single night at the same time of year; a driver would feel that luck was decidedly against him if he did not secure a larger series in two nights.

For example, two cars on May 25, 1935, in the same area, secured the following live snakes: 5 *S. occipitalis*, 1 *C. cerastes*, 6 *P. d. perkinsi*, 5 *A. e. occidentalis*, and 1 *Lampropeltis getulus californiae*, a total of 18 live snakes in one night, compared to the other collector's 13 in two weeks. Besides this, the auto hunt secured 7 additional DOR snakes suitable for preservation (6 *P. d. perkinsi*, 1 *A. e. occidentalis*) and 30 live *Coleonyx variegatus*.

On a number of occasions, having become discouraged by the poor luck experienced in driving, my companions and I have hunted afoot by the roadside. Occasionally a snake has been found, but on the whole we have never bettered our total catch by this reversion to the older method. I think the best one-night bag by a collector afoot of which I have heard was 4 *C. cerastes* and 3 *A. e. occidentalis.* But as many as 19 live snakes of seven different species have been secured by an auto party in a single evening.

Analysis shows that relative results such as these are to be expected. In a car traveling fifteen miles per hour on a roadway twenty feet wide (including shoulders) a person covers fifteen times as much area as a hunter on foot with a lantern; for the latter cannot do better than two miles per hour, nor can he carefully inspect, even with the best available type of lantern, a width exceeding ten feet. In fact in a rough or brushy country he will do well to cover one mile per hour. Even if we assume that the reptiles are denser per unit of area in the primitive territory distant from the road, the driver has much the better chance. For the hunter afoot is handicapped by the lack of color contrast between his prey and the ground surface; and his vision is impaired by vegetation, by rough and debris covered ground, and the shadows of twigs and stones which move as his lantern swings. He never knows how many specimens remain undiscovered as he passes by. They are in their natural element and all their provisions for concealment are effective. Even so brightly colored a little snake as *Sonora occipitalis* is difficult for the eye to separate from the knobby shadows of twigs which his cross-bars seem to match. But the hunter in the car has no such handicap, his prey is in the open, conspicuous against a sharply contrasting background.

Some professional desert collectors work afoot but they do not ordinarily collect at night. Their usual practice is to get out just before sunup and hunt for tracks in the sand. As the snakes have not yet gone into hiding for the day, almost every fresh track leads to a capture. The snakes caught by this method are mostly rattlers, especially *Crotalus cerastes, C. cinereous,* and *C. scutulatus.*

When it comes to daylight collecting the auto driver has by no means the advantage over his competitor afoot that he has at night. Snakes are more careful of concealment in the daytime; they do not roam across the roads so frequently, and therefore may best be hunted afoot amongst rocks, brush, and cacti, and along the borders of streams or ponds.

PAVED COMPARED WITH UNPAVED ROADS

I have mentioned the disadvantages of unpaved roads, as compared with those which are surfaced, especially if the latter be black. The unevenness of the dirt roads, the dust and the shadows of the corrugations, the lack of color contrast between the snakes and the surface, and the shaking of the car itself, all make it difficult to see the quarry on the road, this being especially true of such small forms as *Sonora, Phyllorhynchus, Hypsiglena,* and *Leptotyphlops.* And when they are seen they are more likely to escape, for on paved roads they find rapid motion prevented by the lack of traction on the smooth surface.

With the idea of trying new territory, or seeking snakes in some particular surroundings, I have occasionally scouted unpaved side roads. On other occasions I have been compelled to use unsurfaced roads, since no others were available to my destination. These trips have been disappointing; the catches have seemed to me to be consistently below what they were on comparable paved sections. As an example, one evening (May 23, 1936) we rode 37 miles on a paved highway, and secured 5 live snakes, 6 geckos, and 3 DOR specimens. We then turned aside on an unsurfaced road where conditions of vegetation and soil seemed particularly good, yet in 11 miles of travel failed to find a single specimen.

The only advantage which the unpaved road can claim is in the tracks left by the snakes which cross. Occasionally these are visible to the driver at night and a snake may be found by trailing him; but following tracks at night is usually not as efficient as in the daytime, when a fresh track frequently leads to a capture. These strictures on unpaved roads are, in fact, applicable only to night collecting; in the daytime the presence of the crossing tracks and the greater snake populations in the more primitive territories render the unpaved highways to be preferred, if one has no objection to dust and a bumpier drive.

CASUALTIES ON HEAVILY TRAVELED ROADS

I have stated that one of the reasons why main highways are poor collecting fields is the heavy mortality of the reptiles living along their borders. This necessarily keeps the population thinned out, despite a continued influx from the surrounding territory. The DORs are evidence of the steady toll.

I have no desert data to illustrate this effect, since I have no results immediately following the opening of a desert highway, not complicated by weather and other variables. From the coastal side of the mountains in San Diego County, I have such an example which is of interest. In 1935, a new short-cut was opened on the San Diego-Tijuana highway in the vicinity of Otay. I looked this road over on May 29th of that year, and found sixteen dead snakes within a distance of 1.3 miles. There were 3 *Coluber flagellum frenatum,* 4 *Pituophis catenifer annectens,* 4 *Lampropeltis getulus californiae* (all striped phase), 3 *Rhinocheilus lecontei,* 1 *Arizona elegans occidentalis* and 1 unidentifiable. This high concentration, the greatest number of DOR snakes that I have ever found within a short distance, was not entirely attributable to the newness of the road; for there were several cuts which caused the crossing snakes to be trapped and subsequently prevented their bodies from being blown away after they had dried out.

I checked the same road a year later (May 20, 1936). There were then only four dead snakes—3 *R. lecontei* and 1 *P. c. annectens.* Two years after this (June 3, 1938) there were three DORs— 2 *C. f. frenatum* and 1 *Crotalus viridis oreganus.* Since the conditions with respect to the effect of the cuts were the same in the three years, I think we are safe in concluding that the population contiguous to the highway had been decimated by the casualties among the snakes crossing it.

EFFECTS OF TIME AND TEMPERATURE ON ACTIVITY

I wish it were possible to demonstrate statistically the effects, upon reptile activity, of the different conditions of weather and environment that are met with in the desert. But there are so many variables of season, air temperature, ground temperature, humidity, wind, moon, soil, vegetation, etc., that, although I have before me the result of about 180 night collecting trips, I find it difficult to correlate the snakes per mile with any single variable with any considerable assurance. No doubt controlled field or laboratory experiments will be necessary before really accurate conclusions can be drawn with respect to these variables. But our experiences of the past ten years have given those of us, who have participated in these night drives, certain ideas concerning the effects of these variable conditions upon reptile activity. The conclusions thus drawn may be too much predicated upon hunches rather than calculations; nevertheless I shall cite the results of certain trips which tend to validate some of the conclusions we have reached.

We believe that, in the spring, only the early evening is normally warm enough for the snakes to be active; as soon as the temperature drops they retire to their subterranean retreats and thus avoid the danger of being abroad when the chill has stiffened their muscles.

For example on May 11, 1935 four live snakes were taken in the Borego area between 7:20 and 7:45 P.M.; additional driving up to 10:45 produced nothing but DOR specimens. On another trip on the road to Blythe, May 14, 1937, we got 5 live snakes in the early part of the evening and only 2 specimens thereafter, although the latter part of the trip was in better territory and the snakes had been active there earlier in the evening, as was shown by the prevalence of DORs.

In another experience of the same kind (April 25, 1936) the Borego area was worked from 6:20 to 10:00 P.M. In the first 25 miles, up to 8:00 o'clock, 6 snakes were collected. There was a strong wind blowing. The temperature varied from 80° to 76° F. In the last two hours the temperature fell to 73° F. and below and in 36 miles over the same territory not a live snake was seen.

The Mohave desert reaches its peak about two weeks after Borego. An example of the disappearance of the snakes as the desert cools off is well illustrated by the following detailed log of a trip at a time when the season had been delayed by unseasonably cool weather. On May 29, 1938, starting at 7:00 P.M., my daughter and I drove south from Lava Mts. (just north of Johannesburg) through Red Mountain, Atolia, Kramer, and Adelanto, thence east to Victorville, a distance of 71 miles. All of these points are in San Bernardino County, Calif. This is a good collecting area over which I have made a number of night hunts. The results of this trip (omitting DOR lizards) were as follows:

Sonora occipitalis, COR*, Lava Mts., 7:22 P.M., 76° F., (under a Joshua tree; breezy; no moon; sunset at 7:00 P.M.).

Pituophis c. deserticola DOR*, 6 mi. N. of Red Mt., 7:40 P.M., 77° F. (not quite dark).

Pituophis c. deserticola COR, 6 mi. N. of Red Mt., 7:43 P.M., 77° F. (almost dark).

Arizona e. occidentalis COR, 4 mi. N. of Red Mt., 7:50 P.M., 78° F. (slight breeze; dark).

Pituophis c. deserticola DOR, 2 mi. N. of Red Mt., 8:00 P.M., 77° F.

Sonora occipitalis DOR, Red Mountain, 8:15 P.M., 71° F.

Crotalus cerastes COR, 3 mi. S. of Atolia, 8:30 P.M., 73° F. (slight breeze).

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* COR, caught on the road alive; DOR, dead on the road, that is, an auto casualty.

Rhinocheilus lecontei COR, 4 mi. S. of Atolia, 8:35 P.M., 70° F.
Sonora occipitalis DOR, 7 mi. N. of Fremont, 8:44 P.M., 67° F.
Sonora occipitalis DOR, 2 mi. N. of Fremont, 9:00 P.M., 64° F.
Sonora occipitalis DOR, Fremont, 9:06 P.M., 64° F.
Rhinocheilus lecontei DOR, Fremont, 9:07 P. M., 65° F.
Rhinocheilus lecontei COR, Kramer, 9:25 P.M., 66° F. (no wind).
Arizona e. occidentalis DOR, Kramer Hills, 9:45 P.M., 61° F. (snake still writhing).
Phyllorhynchus d. perkinsi DOR, 11 mi. N. of Adelanto, 10:16 P.M., 64° F. (snake still writhing).
Coleonyx variegatus COR, 10 m. N. of Adelanto, 10:20 P.M., 64° F.
Sonora occipitalis DOR, 9 mi. N. of Adelanto, 10:25 P.M., 63° F.
Arizona e. occidentalis DOR, 8 mi. N. of Adelanto, 10:30 P.M., 63° F. (snake still writhing).
Sonora occipitalis DOR, 8 mi. N. of Adelanto, 10:31 P.M., 61° F.
Crotalus cerastes DOR, 6 mi. N. of Adelanto, 10:40 P.M., 62° F.
Rhinocheilus lecontei DOR, 5 mi. N. of Adelanto, 10:42 P.M., 60° F.
Sonora occipitalis DOR, 3 mi. N. of Adelanto, 10:50 P.M., 60° F. Reached Victorville at 11:15 P.M., 58° F.

We have here a record of 21 snakes and a gecko, seen in 71 miles of travel, within slightly over four hours. Of the 21 snakes, 6 were caught alive; all of these were encountered in the first half of the evening, and 5 within the first hour and a quarter. All of the dead specimens, except one, showed by their condition that they had been run over during the current evening. Three were still squirming, and had been injured within an hour or so. The road is one of light travel—not ten cars per hour at this time of night, I should say. With so extensive a casualty list and so few cars, we know there must have been a great many snakes active in the early evening, and that they were moving slowly across the highway, as they are wont to do when they are cold, and they welcome the heat stored in the pavement. But later, after about 9:00 o'clock, when the air temperature had fallen to 65° F., or below, nearly all had sought their subterranean retreats and only the casualties remained.

This early retirement of the snakes is not characteristic of the nocturnal species; that is, it is not evident on nights when the temperatures hold up, for they are active at least until midnight and probably till dawn, as will be shown by the species statistics. On the night in question there was no moon, and little breeze. The ground temperature was relatively low for this time of year. Hence, we have in this night's experience, a rather definite proof that nocturnal snakes come out early when temperatures are below the optimum, and soon retire when the temperatures have fallen still further.

In contrast on another night (June 1, 1935) the temperature held up to 75° at midnight. In the first half of the evening, from 7:20 until 9:40, we got 6 live snakes and 15 geckos; in the last half, from 9:40 to 12:00, 7 live snakes and 7 geckos—we tired of stopping for the latter. No doubt the snakes were out all night; we went home at midnight.

But it should not be thought that one has only to strike a night when the temperature is propitious to find good collecting. Such is not the case. Thus we worked the Borego area Sept. 21, 1938, on a dark, windless night and with the temperature varying from 86° F. at dusk to 73° F. some two hours later. These would be ideal conditions in the early spring, but not a single specimen was seen dead or alive. This result is from a seasonal rather than a temperature cause.

If temperature were the only important factor one could start on the floor of the desert any time in the summer at a temperature above the optimum and drive up some mountain or great alluvial fan until he reached a condition below the optimum. Somewhere between he must pass through a zone having an ideal temperature where the snakes should be plentiful. But this scheme doesn't work for I have tried it on several occasions. For example, working out of Boulder City, Nev., on June 15, 1936, where the temperature was over 90° F. shortly after dusk, I drove to a point in the Charleston Mts., at an altitude of 7500 ft. where the temperature was below 70° F. In 95 miles of night patrolling only a single specimen, a DOR *Lampropeltis g. californiae,* was found. It was simply not the season of snake activity in that territory.

In the late spring, when the desert temperatures are rising rapidly, there may be a rather sudden cessation in seasonal activity. Thus on the night of June 1, 1935, 13 live snakes were collected in the Borego area and 6 others were noted run over on the road. The temperature varied from 87° F. down to 75° F. Following this there was a hot spell, the diurnal temperature going to 116° F., and the early evening figure was close to 100° F. On three successive evenings, beginning two nights later, the same territory was worked with the following results: June 3, 4 COR; June 4, 4 COR; June 5, 2 COR, 1 DOR.

By July the night temperatures are so high and the spring activity so definitely terminated that we try little collecting. Thus on July 30, 1935, this territory was worked again and only 2 DOR snakes were noted. The same trip was made on August 16, 1936, between 1:00 and 3:30 A.M. The temperature was down to 81° F. but only one DOR snake was seen. A live *C. ruber* was found off the road, under a bush.

July and August are equally barren periods in the coastal area. For example on July 15, 1938, I drove 363 miles through what would have been good diurnal territory in the spring and saw only 2 DOR snakes.

Miscellaneous Variables

As an example of how a very severe wind may affect collecting, the night of May 30, 1936, may be mentioned. We hunted in proven territory from 6:50 to 11:30 P.M., covering 145 miles. The temperature was in the neighborhood of 75° F. but later fell to 65° F. The wind was so strong that at one point we received such a shower of stones when crossing a wash (the road was paved) that the paint of the car was damaged considerably and the replacement of the windshield glass became necessary. On the entire trip only a single reptile was seen, a *Coleonyx variegatus,* which was found alive on the road at 10:20, a gale blowing, and the temperature 64° F.

Two trips which seem to differ only in the phase of the moon, were taken in the Yuma-Somerton-Gadsden area, in extreme southwestern Arizona. The temperatures and wind conditions were about the same on the two nights. The first cruise of 70 miles during the evening collecting period, produced 5 live snakes. There was no moon. Two weeks later and presumably nearer the peak of activity (May 4, 1936) with a full moon, only one snake was collected in 55 miles.

I have mentioned the high incidence of young of the year in the autumn, when they have but lately been born and have not yet become cautious. At this season, before the high mortality amongst them has been completely effective, these juveniles comprise a considerable percentage of the total population* and naturally constitute a noticeable proportion of both the CORs and the DORs met in the highway hunts. Thus on Sept. 15, 1938, out of 6 snakes noted at night on the Mohave Desert 3 were juveniles. One evening a few days later in the Borego area only 2 snakes were found and both were juveniles. In early September, 1937, I was traveling down the east side of the Sierras in Nevada and California. In two days (the 3rd and 4th of the month) and 542 miles of travel, largely in daylight, we noted 45 snakes alive or dead on the highway, mostly the latter. Of these 22 were juveniles. The racers *Coluber taeniatus taeniatus* in western Nevada, and *Coluber flagellum frenatum,* further south in Inyo County, California, comprised a high proportion of these young.

Sometimes I have been led to infer a correlation between the prevalence of rats and mice on the road and the snake catch. Thus on June 21, 1935, in the vicinity of Bakersfield, collecting was unusually good—we secured 10 live and 2 fresh DOR specimens in less than two hours and with only 30 miles of travel. Rodents were so plentiful that there was seldom a time at least one was not hopping on the road within the range of the headlights. I tried the same territory on the night of June 23, 1937, without finding a single reptile. Few rodents were out, so it appeared that whatever conditions of weather or moon caused the difference in reptile activity similarly affected the mammals.

On another occasion in the autumn we traversed a 24-mile section of the Borego road between 6:40 and 8:20 P.M. Only three mammals were seen, a pocket mouse, a kangaroo rat, and a wood rat. No snakes were found either dead or alive. In the next 5 miles, up to the foot of the mountains, rodents were quite plentiful, over a dozen flitting across the road; and in the same stretch two live snakes were captured.

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*For an estimate of this percentage amongst the rattlers see Occ. Papers, S. D. Soc. Nat. Hist., No. 1, pp. 14-24, Aug. 10, 1936.

In all of my experience in night collecting I have never come upon a snake feeding on the road. On April 24, 1932 in the vicinity of Sloan, Nevada, at 8:30 on a cold, windy night, the headlights suddenly disclosed a *Rhinocheilus lecontei* facing a mouse which was hopping slowly on the road a few feet away. But the lights disturbed them so that it was impossible to tell whether the snake was actually in search of prey.

I have mentioned the apparent reduction in the snake population where the vegetation becomes too sparse. For example, beyond Benson's Dry Lake (or Ocotillo), in eastern San Diego County, there is a sharp change in the cover, the plants becoming smaller and more scattered. The effect on the reptile catch is so obvious that in most of our shuttle hunts in this area we turn around at this point. I may cite, as an example of the kind of difference we have observed, the night of May 20, 1938, when I covered 62 miles, 24 in the good territory, 38 beyond. In the first 24 miles we got 8 snakes and 7 geckos; in the last 38 in the more barren territory, only 1 snake. The temperature and wind conditions were actually better, with a higher temperature and less wind (for the temperature was well below the optimum) in the barren than in the fruitful territory.

After all the variables of season, climate, and temperature have been canvassed there remains the matter of pure luck. How else are we to explain the fact that on the night of June 5, 1938, C. B. Perkins and I, cruising together on the road to San Xavier Mission near Tucson got two live specimens of *Phyllorhynchus browni* within 4 minutes and less than a mile apart? This was the snake we had come over 400 miles to collect and we were naturally elated. Yet on 4 consecutive nights (our lucky night was the second) we spent a total of 13½ hours and traveled 302 miles, much of it shuttling on this same stretch of road, without securing another live specimen. We did get one DOR later the same night. So far as we could see there was no difference in the successive nights except that the lucky one seemed to be somewhat humid, and even on that night we had only 5 lucky minutes out of 260. The moon was on the increase during the four nights; but if that were the controlling factor the first night should have been the best.

How good does this collecting ever get? Sometimes it is quite astonishing. Here are the results of 35 minutes (8 miles of travel) from 10:25 to 11:00 o'clock on the night of June 25, 1938, in the vicinity of The Narrows, San Diego County, temperature about 88° F.

1 *Phyllorhynchus d. perkinsi*	10:25
1 *Arizona e. occidentalis*	10:27
1 *Crotalus cerastes*	10:35
1 *Phyllorhynchus d. perkinsi*	10:35
1 *Phyllorhynchus d. perkinsi*	10:36
1 *Phyllorhynchus d. perkinsi*	10:40
1 *Arizona e. occidentalis*	10:53
1 *Phyllorhynchus d. perkinsi*	11:00

All of these snakes were found crossing the road. This was at the rate of one live snake per mile or one in each 4½ minutes.

But the collector who expects trips such as this as a regular thing is doomed to discouragement. He must be prepared for some like these:

June 16, 1936, 4¾ hours, 190 miles, 2 dead snakes.
May 30, 1937, 3¾ hours, 96 miles, 1 dead snake.
June 7, 1938, 3 hours, 73 miles, nothing.

These trips were in good desert areas and under satisfactory temperature conditions; however it is fair to say that they were not in our favorite Borego area. The collector who wishes to give night collecting by auto a serious trial must be prepared for the fluctuations of chance. If he is working a new territory it may be necessary for him to determine by experiment the optimum condition of season and temperature before he can achieve a substantial success.

STATISTICAL DATA

Thus far I have discussed night driving to describe some of the methods which have been found efficient, and have used a few selected trips to illustrate certain features of the results. I now wish to present various statistics derived from the trips which have been made, to summarize what we have learned with respect to the habits and habitats of particular species. As it would be confusing to combine several groups of animals in a single treatment I shall touch separately on the amphibians, lizards, and snakes. Of these the snakes comprise the group with respect to which nocturnal road collecting has proved most satisfactory; for this reason they will be discussed in greater detail than the others. I have never come upon a turtle or tortoise on a desert road at night, hence this group is not included.

Amphibians

One usually thinks of the desert as a habitat unsuited to amphibians but such is not the case. In many desert areas of the southwest there are springs, seeps, and sinks where frogs and toads are to be found; others live amid rocky canyons where there are intermittent streams fed by precipitation at higher elevations. With the coming of irrigation some large territories have been converted to a condition well suited to amphibian life. Into these amphibians quickly find their way, usually from the same source and by the same canals as the water itself. Thus we find the Coachella, Imperial, Palo Verde, and Yuma irrigation districts heavily populated with toads. They are the typical forms of the Colorado River rather than of the coast; for although the frogs and toads of the coast are found on the eastern slope of the mountains and follow the streams down that slope until the water sinks in the desert, they do not seem as yet to have become established in the newly irrigated areas. This is particularly surprising in the case of the Coachella Valley, which is quite near the eastern base of the mountains, and at present secures much of its water by pumping from wells. But the toads there are the typical Colorado River forms, *Bufo alvarius, B. woodhousii,* and *B. cognatus,* rather than the coastal and mountain forms, *B. boreas halophilus* and *B. californicus.* The Colorado River fauna must have entered the Coachella Valley by way of the Salton Basin in the days of the overflow.

In our desert trips at night, particularly in these irrigated areas, amphibians are often heard calling from the fields and ditches, and many are seen in the headlights while crossing the road. This is especially true in the spring in the Colorado Desert areas; and in the summer, after the first rains, in those sections where summer rains occur, such as the vicinity of Casa Grande and Tucson, Arizona.

But from the standpoint of a special technique I do not consider that nocturnal road collecting offers any important advantages in the capture of amphibians. A good many specimens can be secured on the road if one cares to stop for them; and the DORs, as always, supply an ample source of locality records. But if one is primarily interested in the collection of amphibians, he had best dismount and hunt afoot in the usual way, as soon as he has been advised that suitable territory has been reached, either by their croaking or the presence of specimens hopping across the road. Certainly he will find them more easily and in greater numbers in the fields, canals, or drainage seeps than on the road.

LIZARDS

Our collecting by auto at night has proved two things: diurnal desert lizards are occasionally active at night; and, of the nocturnal lizards of the Southwest, the desert gecko, *Coleonyx variegatus,* is the only one which is extensively active in the open spaces. It is the only lizard the collection of which has been facilitated by the scheme of night driving.

The hours of activity of our diurnal lizards vary both with the season and the species. As spring advances they are active earlier, before the heat becomes uncomfortable or dangerous. Species almost exclusively desert in habitat are likely to come out somewhat later in the morning than those which range through both the Upper and Lower Sonoran zones. For example *Cnemidophorus tessellatus tessellatus* is usually seen earlier than *Dipso-saurus dorsalis dorsalis. Uta mearnsi,* a rock dweller, is active quite early in the morning. *Uta stansburiana stejnegeri* has been observed as early at 5:30 A.M.

In the hottest part of the summer, lizards are active only in the early morning and in the late afternoon. Some observers consider the latter period as good a collecting time as the morning, but I have not found it so; to me it has appeared that the afternoon activity is less extensive than the morning. At any rate some diurnal lizards are out at dusk, and our driving has shown that a few may be out late into the night.

The following schedule lists the occasions upon which diurnal lizards have been observed active on the road at night. All of the times given are P. M., unless otherwise stated, and the temperatures are in degrees Fahrenheit.

In all instances it was sufficiently dark to require headlights for visibility.

Dipso-saurus dorsalis dorsalis: 9:05, 9:40 (92°), 9:55 (88°), 10:50 (89°).

Callisaurus ventralis gabbii: 7:10, 7:59 (81°), 9:45, 11:40 (89°), 1:15 A.M. (90°).

Uta graciosa: 7:05 (82°), 7:15, 7:50 (82°), 7:50 (89°), 8:35, 8:41.

Uta stansburiana stejnegeri: 7:15 (86°), 8:00 (81°), 9:04 (69°), 9:15 (76°), 10:35 (83°).

Sceloporus magister magister: 7:42.

Phrynosoma m'callii: 8:00.

Phrynosoma platyrhinos platyrhinos: 7:35, 7:50.

Phrynosoma solare: 8:08 (84°).

It will be observed that, of the last four species, no individuals have yet been found out much after 8 o'clock; thus a real night activity is not shown with certainty—they were merely an hour or so late in retiring. With respect to the other species some night activity is definitely indicated. In some cases the individuals were found in a somewhat dormant mood; in others they were so lively that they could hardly be caught. With respect to all of these species, having in mind the number of trips and the mileage covered, the number of individuals seen has been so small, compared with the number which might be expected in similarly extensive daylight trips, that night activity seems to be quite out of the ordinary. Only in the case of *Uta graciosa* is there any indication that nocturnal activity may be relatively important. This lizard seems to spend the summer nights on the creosote-bush branches where it is found in the daytime. All of the others, as far as is known, seek rock crevices or ground holes at night, or bury themselves in sand, or hide beneath stones, or under fallen yucca or cactus stems.

Of the diurnal lizards of the southwest whose names do not appear in this list, and of which therefore, night activity has not been demonstrated, the most conspicuous are *Cnemidophorus tessellatus tessellatus, Crotaphytus wislizenii, Crotaphytus collaris baileyi, Sauromalus obesus,* and *Uma notata. Crotaphytus collaris baileyi* has been observed in the open a short time after sunset.

Coming now to the truly nocturnal lizards of this area, we have four: *Phyllodactylus tuberculosus, Xantusia henshawi, Xantusia vigilis,* and *Coleonyx variegatus.* The first two are rock dwellers and are therefore to be expected only in the limited areas where boulders of the proper type border the road. Evidently even here they do not often venture to cross a road; I have only records of one *X. henshawi* at 7:38 P.M., and of two *P. tuberculosus* at 8:35 P.M. (85°) and 8:45 P.M. (86°). The latter were taken by Jas. Deuel on the nights of Sept. 23 and 24, 1938. *Xantusia vigilis* has not yet been observed on the road at night; possibly its size accounts for this, as it is the smallest of our southwestern lizards. No doubt it prowls actively about at night amongst the dead yucca stems and other debris in which it lives, but does not often cross the open road. I have occasionally looked for it when driving through groves of Joshua trees, just to secure a record, but without success.

As a means of collecting the several species of diurnal and nocturnal lizards which have been discussed, the night driving scheme is not to be recommended, since other more fruitful methods are well known; the results of our experiences are merely given as they reflect on habits. But in the case of *Coleonyx variegatus*, the banded or desert gecko, the situation is quite different; for ordinarily this lizard is more plentiful on the road at night than all other lizards, or in fact, than all lizards and snakes together. As many as 30 have been encountered in a single night and often we do not trouble to keep a record of those seen. As they were formerly collected only by the hard work of prying off rock flakes, and overturning yucca stems or other debris, night driving has converted a rare into an exceedingly common species. From the coastal side of the mountains, where we are still restricted to the older methods, comparatively few specimens are even yet available.

Coleonyx has been met with on the road in a great variety of situations. It is found in every kind of desert habitat and up to an elevation of at least 4000 ft.; in rocks, brush, cacti and on sandy flats, although probably most common in the latter. It is an important food element on the menu of the nocturnal desert snakes, particularly *Phyllorhynchus*, which, when not large enough to engulf a full grown lizard consumes its tail at least. *Coleonyx* eggs are also eaten by *Phyllorhynchus* in the spring and early summer.

If one is traveling slowly the geckos are rather easily seen on the road, as they are almost white laterally. Usually they cross slowly and appear like bits of paper blown along the highway. They will often remain quiet if the car is stopped quickly enough to hold the headlights on them; if they are passed they will occasionally escape. No eye shine has been observed.

Although their skins are so thin as to be partially translucent and they have the appearance of being delicate and fragile, they must actually be quite hardy. For while they prefer warm spring nights, they have been found active on nights when the temperature was close to 60° F. and with so violent a gale blowing that it was difficult to see how they could cling to the highway surface. I think I have seen them out under more extreme weather conditions than any other desert reptile except possibly *Crotalus cerastes*. However I have never encountered one in full daylight except on one occasion when no place of concealment was available. This was on a tiny island on Lake Mead (June 16, 1936) which was about to be inundated by the rising water of the dam. There were two geckos in plain sight; one was shedding in a peculiar fashion—possibly burned by the sun.

As to the seasonal activity of *Coleonyx variegatus* the following records of the number found on the road each month are at hand:

March	1
April	43
May	207
June	60
July	22
August	16
September	8
October	4
Total	361

This result may be partly an index to our own activity rather than that of the geckos; I therefore present another table covering only the Borego area in San Diego County and reduced to a mileage basis:

Month	Specimens	Miles	Specimens per 100 Miles
March	0	42	0
April	32	256	12.5
May	155	871	17.8
June	50	349	14.3
July	13	215	6.0
August	12	133	9.0
September	7	385	1.8
October	4	97	4.1
Total	273	2348	11.6

The best trips disclose specimens at the rate of about 37 specimens per 100 miles (22 specimens in 60 miles, June 1, 1935, Borego area). It seems safe to conclude that the spring is the season of maximum activity.

As to the time of night when they are most active, I have records of about 200 specimens of which the time of collection was noted. These are as follows:

Time	Live Specimens
6:30 to 6:59 P.M.	1
7:00 to 7:29	16
7:30 to 7:59	20
8:00 to 8:29	29
8:30 to 8:59	38
9:00 to 9:29	24
9:30 to 9:59	22
10:00 to 10:29	17
10:30 to 10:59	16
11:00 to 11:29	9
11:30 to 11:59	6
12:00 to 12:29 A.M.	1
12:30 to 12:59	3

1:30 to 1:59	1
3:00 to 3:29	1
3:30 to 3:59	1
	205

It should be pointed out that this table does not give a true picture of the relative time of activity since much more collecting was done early in the evening than later. The lizard may be just as active in midsummer after midnight as before; we have the data on few trips during those hours. But in spring they certainly are more active early in the evening before the desert has cooled off. The earliest specimen was found at 6:33 P.M. Sept. 27, 1938; the latest at 3:37 A.M., Aug. 16, 1936 (the latter by Miss Elizabeth Sprague). It has been my experience that the first individuals may be out before darkness is complete but they are not most active until later. This is correctly indicated by the table, since, while the later hours (after 11:00 P.M.) are not fairly represented, the early hours are; for these trips were begun at dusk, and if the geckos had been out they would have been recorded. We conclude that maximum activity is reached about three hours after sunset. In the summer this may continue all night, but in the spring the lizards retire to a large extent as the desert cools off.

The temperature conditions at times when *Coleonyx* has been found may be summarized as follows:

Temperature deg. F.	Specimens
60 - 64	9
65 - 69	1
70 - 74	4
75 - 79	19
80 - 84	48
85 - 89	21
90 - 94	5
Total	107

It will be noted that nearly half were taken at temperatures of 80° to 84° F. inclusive. As the average temperature, when all our desert night drives are taken into consideration, was distinctly below this range, there is no question but that a definite preference is here indicated, and that the optimum temperature for this species is slightly above 80° F. The highest air temperature noted when a specimen was collected was 92° F. and the lowest 62° F. I am quite certain I have collected *Coleonyx* at temperatures below the latter figure, but unfortunately no temperature records were then made.

SNAKES

In summarizing the benefits which have accrued from night collecting by driving, I have stated that the scheme has improved our collections through the accession of many specimens of nocturnal forms previously thought rare; and by adding to our knowledge of ranges, habitats, and habits. The first point requires no discussion; it has aided us in securing hundreds of specimens of such forms as *Phyllorhynchus decurtatus perkinsi, Sonora occipitalis,* and *Arizona elegans occidentalis,* which were formerly considered so unusual that a single specimen was an ample reward for a collecting trip. I am certain it would do the same for *Phyllorhynchus browni, Chilomeniscus cinctus, Ficimia cana,* and *Sonora miniata* if their territories were more readily accessible to us. As to ranges and habitats, the night trips supplement, rather than supplant, the information acquired from a record of the DORs found on the day trips. But habits, particularly with respect to the conditions affecting nocturnal activity, can only be determined through data secured on the night drives, for a specimen must be alive if we are to be certain of the conditions surrounding its activity. I now turn to the results which may be deduced from the statistics available. These include considerable material not intimately connected with night driving.

TIME OF ACTIVITY

One of the first items of information to be developed is the relative degrees of diurnal and nocturnal activity which snakes exercise. I think the best criterion on this point is the number of snakes found crossing the road in the daytime and at night. Such snakes are better indicators of activity than individuals found by the roadside, or in hunts afield under bushes, or in other semi-concealment, since snakes known to be nocturnal are not infrequently found in the daytime under shrubs or in open rock crevices. For example, a specimen of *Trimorphodon vandenburghi* was found coiled under a bush, near a pile of granite boulders, at 3:15 in the afternoon of a partly cloudy day; and it is quite customary for sidewinders to lie in front of mammal holes in the morning until the sun gets hot. As to roadside casualties, even when they are still squirming, one cannot be sure of the time when they were struck. But to find a specimen crossing the road usually indicates a real activity; snakes will not ordinarily use so open a space for a long period of rest, although somewhat more disposed to do this at night on the desert than in the daytime on the coast.

Table 1 sets forth the number of snakes found crossing the road, whether on desert or coastal trips, segregated between those found during the day and the night hours.

First it should be stated, with respect to this table, that no attempt should be made to draw conclusions concerning the relative frequency of occurrence of the different species. The mileage of the trips may have been small in territories occupied by one snake as compared to another. For example I have traveled extensively in *Coluber lateralis* territory and comparatively little where *C. taeniatus taeniatus* occurs; similarly I have been much more in *Sonora occipitalis* than in *S. miniata* areas. On the whole I have accumulated somewhat more mileage in daylight on the coast and more at night on the desert, with the grand total daylight miles exceeding the night mileage. Thus on a strictly comparable basis the snakes observed

TABLE 1.

LIVE SNAKES FOUND ON THE ROAD

(Not restricted to desert roads)

Species	Daytime	Nighttime
Western Worm Snake *Leptotyphlops humilis humilis*	....	2
Desert Worm Snake *Leptotyphlops humilis cahuilae*	....	8
California Boa *Lichanura roseofusca roseofusca*	9	6
Western Yellow-bellied Racer *Coluber constrictor mormon*	2	....
Coachwhip Snake *Coluber flagellum flavi-gularis*	1	....
Red Racer *Coluber flagellum frenatum*	17	1
California Striped Racer *Coluber lateralis*	30	....
Western Striped Racer *Coluber taeniatus taeniatus*	3	....
Desert Patch-nosed Snake *Salvadora grahamiae hexalepis*	3	....
Chaparral Patch-nosed Snake *Salvadora grahamiae virgultea*	5	....
Mexican Leaf-nosed Snake *Phyllorhynchus decurtatus decurtatus*	....	1
Desert Leaf-nosed Snake *Phyllorhynchus decurtatus perkinsi*	....	175
Pima Leaf-nosed Snake *Phyllorhynchus browni*	....	2
Western Glossy Snake *Arizona elegans occidentalis*	1	74
San Diego Gopher Snake *Pituophis catenifer annectens*	53	....
Desert Gopher Snake *Pituophis catenifer deserticola**	12	8
Arizona Gopher Snake *Pituophis sayi affinis*	5	11
California King Snake *Lampropeltis getulus californiae*†	6	1
Pacific King Snake *Lampropeltis getulus californiae*‡	10	10
Yuma King Snake *Lampropeltis getulus yumensis*	....	1
Long-nosed Snake *Rhinocheilus lecontei*	1	34
Shovel-nosed Ground Snake *Sonora occipitalis*	2	114
Vermilion-striped Ground Snake *Sonora miniata linearis*	....	2
Banded Burrowing Snake *Chilomeniscus cinctus*	....	1
Spotted Night Snake *Hypsiglena ochrorhynchus*	....	11
Pacific Garter Snake *Thamnophis sirtalis infernalis*	2	....
Southern California Garter Snake *Thamnophis ordinoides hammondii*	13	1
Desert Garter Snake *Thamnophis marcianus*	....	4
California Black-headed Snake *Tantilla eiseni*	....	1
California Lyre Snake *Trimorphodon vandenburghi*	....	4
Desert Diamond Rattlesnake *Crotalus cinereous*	....	3
Red Diamond Rattlesnake *Crotalus ruber*	5	5
Pacific Rattlesnake *Crotalus viridis oreganus*	10	2
Arizona Prairie Rattlesnake *Crotalus viridis nuntius*	1	....
Southwestern Speckled Rattlesnake *Crotalus mitchellii pyrrhus*	4	3
Mohave Rattlesnake *Crotalus scutulatus*	1	7
Sidewinder or Horned Rattlesnake *Crotalus cerastes*	1	57
	197	549

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* Including *P. c. stejnegeri* and *P. c. heermannii*. † Striped phase. ‡ Ringed phase.

at night should be greater in number than given in the table. Other more accurate tables, on a snake per mile basis, are presented later.

In the preparation of the table there has been an occasional doubt concerning the allocation of a particular specimen as between day and night. But our summer twilights in Latitude 33 are not particularly long, and I have arbitrarily separated day from night at the time when the auto headlights had to be turned on, in order that objects on the road might be distinguished—say from a half to three-quarters of an hour after sunset.

I have myself been somewhat surprised at the results disclosed by this tabulation. I had not before appreciated, for instance, that the patch-nosed snakes (*Salvadora*) were so exclusively diurnal; or that *Rhinocheilus* and *Arizona* restricted their activities so largely to the night. Yet the experience here set forth seems sufficiently extensive to be conclusive, at least as far as southern California is concerned, for considerably more than 100,000 miles of travel are involved in this table—nearly 50,000 diurnal miles in San Diego County alone. Surely if *Arizona elegans occidentalis*, which is a rather common snake, were generally active in the daytime, more than one would have been observed in this distance.

From the table it is possible to classify the species in several broad groups. In making this classification, where a species is poorly represented in numbers, I have been guided somewhat by experiences acquired elsewhere than on the road. Also I have chosen to overlook the occasional stray specimen found at an unusual time—for example the two percent of *Sonora occipitalis* active in daylight.

1. Exclusively diurnal forms found in both coast and desert:
    - *C. f. frenatum* (also *C. piceus*)
2. Exclusively nocturnal forms found in both coast and desert:
    - *A. e. occidentalis*
    - *R. lecontei*
    - *H. ochrorhynchus*
    - *T. eiseni*
    - *T. vandenburghi*
3. Diurnal forms having coastal and desert subspecies or analogues:

Coast	Desert
C. lateralis	*C. t. taeniatus**
S. g. virgultea	*S. g. hexalepis*

4. Nocturnal forms having coastal and desert subspecies or analogues:

Coast	Desert
L. h. humilis	*L. h. cahuilae*

5. Exclusively diurnal coastal forms without desert analogues:
    - *C. c. mormon*
    - *T. s. infernalis*

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*But not found in extreme Lower Sonoran areas such as the Mohave, Colorado, and Yuma deserts.

6. Exclusively nocturnal coastal forms without desert analogues:
   None
7. Exclusively diurnal desert forms without coastal analogues:
   None
8. Exclusively nocturnal desert forms without coastal analogues:
   P. decurtatus
   P. browni
   S. occipitalis
   S. miniata
   C. cinctus
   C. cerastes
9. Forms largely diurnal on the coast which tend to become crepuscular or nocturnal on the desert, either in the same form or as an analogue:

Coast	Desert
L. r. roseofusca	*L. r. roseofusca* and *L. r. gracia*
P. c. annectens	*P. c. deserticola* and *P. s. affinis*
L. g. californiae	*L. g. californiae* and *L. g. yumensis*
T. o. hammondii	*T. marcianus*
C. ruber	*C. ruber* and *C. cinereous*
C. v. oreganus	*C. v. oreganus* and *C. scutulatus*
C. m. pyrrhus	*C. m. pyrrhus* and *C. m. stephensi*

Note: There is a close connection between groups 2 and 4 in that the snakes in group 2 may in the future be subdivided into coastal and desert subspecies which would transfer them from group 2 to 4. A similar relationship exists between groups 1 and 3.

Certain conclusions are obvious from this distribution of species. A general tendency of the ophidian population toward nocturnal activity in the desert is evident. There are no diurnal desert forms which have not spread to the coast; nor are there any nocturnal coastal forms which have not spread to the desert. But there are diurnal coastal snakes and nocturnal desert snakes which have not been able to penetrate into the transmontane areas. Almost all of the individuals of *L. r. roseofusca, L. g. californiae, C. ruber, C. v. oreganus*, and *C. m. pyrrhus* which have been found on the road at night have been in the desert area, thus indicating a change of habit with the change in climate and environment. The single specimen of *C. f. frenatum* found out in the early evening was in the desert. The only specimen of *T. o. hammondii* that I have found actively pursuing frogs at night (not on the road, and therefore not in the table) was in the desert at Victorville; another was crossing the road at night in Sentenac Canyon. Thus in all of these classes and examples we see, in the increased nocturnality, the effect of the unbearable diurnal desert temperature, either directly on the reptiles or through the habits of their prey; no doubt the sparser desert vegetation with the relative lack of cover, as compared to the chaparral belt of the coast, also tends to favor a nocturnal existence.

We note that the exclusively diurnal snakes (groups 1, 3, and 5) are swift moving. The exclusively nocturnal desert forms are all small; several are burrowers. All of the essentially night snakes are blotched or ringed except two, *T. eiseni* and *S. miniata linearis,* which are particularly secretive. Swift moving diurnal snakes are often longitudinally striped. No nocturnal snakes are as speedy as the diurnal racers and patch-nosed snakes.

Group 9 contains the more adaptable forms. Most of them are widespread in distribution or have close relatives which are. They not only change their habits in accordance with the climatic conditions of the territory in which they live, but they make seasonal changes as well, shifting from day to night (especially on the desert) as summer advances. For example *T. c. deserticola* is often found out in midday in the spring, but is more prevalent from dusk until late at night in midsummer.

SEASONAL ACTIVITY

Table 2 sets forth the seasonal distribution of the snakes listed in Table 1 which were found at night, together with 12 additional snakes which escaped and were therefore unidentified. While this table is not restricted to desert data, it represents desert individuals to a major degree since only a half dozen specimens have been found in other areas at night. It should be observed, with regard to this table, as in the case of Table 1, that it should not be used in making interspecies comparisons, since many more miles were traveled within the ranges of some snakes than others. Only a relatively small proportion of the miles represented in the table were within the territory inhabited by *S. miniata linearis* for example, or *C. scutulatus,* or *T. marcianus.*

We find, as has been evidenced by other statistics, that the spring is the time of principal activity, which activity is later terminated by the end of the mating season and the advent of hot summer nights. There are some seasonal fluctuations from year to year depending on the spring weather. Also the higher, cooler parts of the desert have later seasons than those which warm up more quickly. It is probable that if our hunting trips were better representative of the hours after midnight a relatively greater summer activity would be indicated.

Table 2 cannot be taken as a true picture of the comparative monthly activity of the desert snakes since the mileage varied greatly in the several months. To compensate for this factor Table 3 has been prepared. This indicates that, on a snakes-per-mile basis, June has a slight superiority over May. The difference in total specimens shown in Tables 2 and 3 results from the elimination of all non-desert snakes from the latter table, together

TABLE 2.

MONTHLY DISTRIBUTION OF SNAKES FOUND ALIVE ON THE ROAD AT NIGHT

	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Total
L. h. humilis	..	.	1	.	...	....	1	....	2
L. h. cahuilae	....	1	6	1	....	....	....	....	8
L. r. roseofusca	..		1	5	....	....	....	....	6
C. f. frenatum	....	.	.	.	1	....	....	....	1
P. d. decurtatus	....	..	.	1	..	....	....	....	1
P. d. perkinsi	3	19	66	53	13	8	12	1	175
P. browni	..	...	.	2	..	...	....	.	2
A. e. occidentalis	2	10	34	23	1	2	1	1	74
P. c. deserticola	..	2	3	2	.		1	..	8
P. s. affinis	....	4	3	3	1	....	....	....	11
L. g. californiae	....		6	3	1	....	1	....	11
L. g. yumensis	....	....	.	....	1	....	..	....	1
R. lecontei	1	9	13	7	..	....	4	....	34
S. occipitalis	....	13	67	23	7	3	1	....	114
S. m. linearis	....	..	..	1	1	...	..	....	2
C. cinctus	....	....	1	....	....	....	....	....	1
H. ochrorhynchus	....	3	3	4	1	....	....	....	11
T. o. hammondii	....	....	....	1	....	....	....	....	1
T. marcianus	....	....	....	1	3	....	....	....	4
T. eiseni	....	....	....	1	....	....	....	....	1
T. vandenburghi	....	1	3	....	....	....	....	....	4
C. cinereous	....	....	2	1	....	....	....	....	3
C. ruber	....	1	1	1	....	....	2	....	5
C. v. oreganus	....	....	....	2	....	....	....	....	2
C. m. pyrrhus	....	....	3	....	....	....	....	....	3
C. scutulatus	....	1	...	2	1	....	3	....	7
C. cerastes	1	11	30	8	2	....	4	1	57
Lost, unidentified	....	1	5	5	1	....	....	....	12
Total	7	76	248	150	34	13	30	3	561

with those specimens encountered on certain early trips when adequate mileage records were not kept.

The figures in Table 3 are derived from trips in the areas of southeastern California, southern Nevada, and southwestern Arizona which Dr. Forrest Shreve refers to as the Mohave and Sonoran Deserts;* however they do not include the Mexican portions of the latter.

TABLE 3.

SEASONAL VARIATION IN LIVE SNAKES FOUND ON DESERT ROADS AT NIGHT

Month	Number of Snakes	Miles Traveled	Snakes per 100 Miles
March	....	181	0.0
April	55	1,486	3.7
May	224	4,306	5.2
June	118	2,169	5.4
July	21	727	2.9
August	12	428	2.8
September	28	890	3.1
October	2	97	2.1
Total	460	10,284	4.5

Table 3 is presumed to give only a broad idea of seasonal activity. Local conditions may advance or postpone the seasonal peak. Thus altitude, rainfall, wind exposure, or an unusually cold winter tend to delay the issuance from hibernation. In the western Mohave the season is later than in the Cahuilla or Salton Basin, since the former is at a higher altitude and optimum temperatures are attained later.

In order to indicate whether there is any substantial difference in the time of major seasonal activity amongst the different species, I have calculated in Table 4, for the five most plentiful species, the number of specimens encountered monthly per 100 miles of travel. This, I think, gives a true picture of relative monthly activity. It has not been done with the less numerous species, since, with respect to these, not enough specimens have been encountered to make the figures representative.

It will be observed that *P. d. perkinsi* and *A. e. occidentalis* apparently have later seasons of activity than *S. occipitalis* and *C. cerastes.*

However, to secure a true correlation between species, season, and distance traveled, we find it necessary to restrict our investigation to a still more homogeneous set of data, wherein the variability caused by separate areas having different faunas and different habitat condition is eliminated. For this purpose we consider only the collections made in what we have called

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*Scientific Monthly, Vol. 42, No. 3, pp. 195-213; March, 1936. See map p. 197.

TABLE 4.

VARIATION IN SEASONAL ACTIVITY OF DESERT SNAKES

(Live snakes of the five most common species encountered on desert roads at night, reduced to the number of snakes per 100 miles of travel. Total miles, 10,284.)

Species	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
P. d. perkinsi	0	0.81	1.04	2.03	0.69	1.64	1.24	1.03
A. e. occidentalis	0	0.40	0.69	0.78	0.14	0.47	0	1.03
R. lecontei	0	0.40	0.28	0.28	0	0	0.45	0
S. occipitalis	0	0.52	1.34	0.78	0.28	0.70	0.11	0
C. cerastes	0	0.74	0.69	0.32	0.28	0	0.45	0

TABLE 5.

MONTHLY DISTRIBUTION OF BOREGO SNAKES

(Specimens encountered alive at night)

	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Total
L. h. humilis	....	....	1	....	....	....	1	....	2
L. h. cahuilae	....	1	6	1	....	....	....	....	8
L. r. roseofusca	....	....	1	5	....	....	....	....	6
C. f. frenatum	....	....	....	....	1	....	....	....	1
P. d. perkinsi	3	15	58	47	11	8	12	1	155
A. e. occidentalis	1	7	18	13	1	2	....	1	43
P. c. deserticola	....	....	....	....	....	....	1	....	1
L. g. californiae	....	....	4	1	....	....	....	....	5
R. lecontei	1	7	6	3	....	....	1	....	18
S. occipitalis	....	12	55	15	5	3	1	....	91
H. ochrorhynchus	....	2	3	4	....	....	....	....	9
T. o. hammondii	....	....	....	1	....	....	....	....	1
T. eiseni	....	....	....	1	....	....	....	....	1
T. vandenburghi	....	1	3	....	....	....	....	....	4
C. ruber	....	1	1	1	....	....	1	....	4
C. cerastes	1	3	12	4	2	....	3	....	25
Escaped unidentified	....	....	1	1	....	....	....	....	2
Total	6	49	169	97	20	13	20	2	376

the Borego area, a single 24 mile stretch of paved road in the desert of San Diego County, from Scissors Crossing via Sentenac Canyon, Yaqui Well, and The Narrows, to the San Diego-Imperial County line 3 miles beyond Benson's Dry Lake. Data secured on this short stretch of road may be correlated with a greater certainty that the conclusions do not result from an accidental preponderance of hunting trips at seasons either particularly well suited, or unsuited, to the areas involved.

Table 5 sets forth the distribution of the Borego snakes by months. Table 6 presents the totals reduced to a snakes-per-100-miles basis and indicates an even more marked superiority of June over May than was indicated in Table 3. This is all the more impressive since the Borego area has an early, rather than a late season, in comparison with the rest of the Sonoran desert. Another comparison of interest to be noted with respect to Tables 3 and 6 is the decidedly higher density of snakes on the Borego road, as compared to the other desert areas. This is especially noteworthy if we take the Borego figures out of Table 3. We then have for the two most important months the following:

	Live Snakes per 100 Miles	
	May	June
Borego Road	12.1	17.4
Other Desert Areas	2.9	1.7

Thus it is seen that we give much of our attention to the Borego road, not only because it is the nearest desert section to San Diego, but also because it is the most prolific territory found thus far.

Table 7 corresponds to Table 4; it presents, for the Borego area only, the seasonal distribution of the four most common snakes, reduced to a basis

TABLE 6.

Variation in Seasonal Activity

(Live snakes encountered on the Borego road at night per 100 miles of travel.)

Month	Total Live Snakes	Miles Traveled	Snakes per 100 Miles
March	....	43	0.0
April	28	279	10.0
May	130	1,076	12.1
June	78	449	17.4
July	10	354	2.8
August	12	213	5.6
September	19	469	4.1
October	2	97	2.1
Total	279	2,985	9.3

TABLE 7.

VARIATION IN SEASONAL ACTIVITY OF DESERT SNAKES ON THE BOREGO ROAD

(Live snakes of the four most common species, reduced to the number of snakes per 100 miles of travel.)

Species	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
P. d. perkinsi	0	2.87	3.63	8.70	1.41	3.29	2.12	1.03
A. e. occidentalis	0	1.08	1.30	2.45	0.28	0.94	0	1.03
S. occipitalis	0	2.51	4.00	2.01	0.28	1.41	0.18	0
C. cerastes	0	1.08	1.12	0.45	0.57	0	0.55	0

TABLE 8.

TIME DISPERSION OF NOCTURNAL ACTIVITY

(Of the five most common desert snakes)

Time when observed on the road	*P. d. perkinsi*	*S. occipitalis*	*A. e. occidentalis*	*C. cerastes*	*R. lecontei*	Total
5:00 - 5:29 P.M.	....	1	....	....	....	1
5:30 - 5:59 "	....	....	....	....	....	....
6:00 - 6:29 "	....	1	....	....	....	1
6:30 - 6:59 "	....	1	2	....	....	3
7:00 - 7:29 "	3	9	4	3	3	22
7:30 - 7:59 "	8	12	4	6	2	32
8:00 - 8:29 "	18	17	8	3	6	52
8:30 - 8:59 "	22	14	12	8	7	63
9:00 - 9:29 "	12	13	7	4	3	39
9:30 - 9:59 "	17	10	5	7	1	40
10:00 - 10:29 "	6	5	3	1	2	17
10:30 - 10:59 "	13	2	7	4	1	27
11:00 - 11:29 "	8	2	4	....	1	15
11:30 - 11:59 "	1	1	2	1		5
12:00 - 12:29 A.M.	2	1	..	....	....	3
12:30 - 12:59 "	....	....	1	....	....	1
1:00 - 1:29 "	....	....	1	....	....	1
Total	110	89	60	37	26	322

of snakes per 100 miles travelled. *R. lecontei* has been dropped out of this table since there were not sufficient specimens to be indicative.

With respect to the species differences noted in Table 7, the most conspicuous is the evidence that the territorially restricted species, *S. occipitalis* and *C. cerastes*, have earlier seasons of maximum activity than the wider-ranging *P. d. perkinsi* and *A. e. occidentalis*. This is contrary to what might be expected on the theory that the more widely distributed forms should be better able to withstand the cold weather of early spring and would emerge from hibernation first. Such is indeed the case in coastal San Diego County, where species whose centers of dispersal are Upper Sonoran are found to have earlier seasons than those essentially Lower Sonoran. Compare, for example, *Diadophis amabilis similis* and *Coluber flagellum frenatum* in Table 16.

There is one further point to be mentioned with regard to this matter of seasonal activity. In our desert there are likely to be more unfavorable nights (from the standpoint of temperature and wind) in May than in June. Many such nights are included in our mileage figures and affect the averages. It is my opinion that on a basis of equally favorable temperatures, a night in late May is likely to be more fruitful than one in June.

HOURS OF NOCTURNAL ACTIVITY

Table 8 presents the data with respect to the time of capture (live snakes only are included) of the five most plentiful snakes on the desert. It is probable that this table gives a reasonably accurate picture of the onset of activity in the early evening, but not of its decline later in the night, since our own efforts often ceased between 10:00 P.M. and midnight. Also it is to be remembered that our hunts were heavily concentrated in the spring; it is probable that an equal mileage in midsummer, particularly if distributed throughout the night, would indicate a later onset and a considerably later peak. In other words the summer activity may be largely restricted to the hours of minimum temperature after midnight. However, the few trips which have been made in such late hours indicate that this activity never reaches the degree involved in the spring mating season. Assuming that we had available a table representing an equal mileage during every hour of the night and in every month, the effect of the spring would still produce an early evening peak as shown in Table 8; but it would not be so marked, and there would no doubt be entries for every half-hour period from midnight until dawn.

As to species differences, Table 8 indicates that *S. occipitalis* is likely to be active before the other species. But a theory which I held in the early days of desert collecting, that the first half hour after darkness was the most fruitful, is not borne out by these statistics. Probably it has some basis in the early spring, when the desert cools rapidly after dark.

Table 9 sets forth such information as is available on the less plentiful species. Since the data are relatively scattered, the exact times of capture are given rather than a tabulation by half-hourly intervals.

TABLE 9.

TIMES WHEN DESERT SNAKES HAVE BEEN OBSERVED ACTIVE ON THE ROAD

(For five most plentiful species see Table 8. All times P.M. unless otherwise stated.)

Leptotyphlops h. cahuilae	6:40, 7:55, 8:29, 9:05
Lichanura r. roseofusca	8:10, 9:14, 10:43, 10:47
Phyllorhynchus d. decurtatus	10:18
Phyllorhynchus browni	8:10, 8:13
Pituophis c. deserticola	7:43, 7:55, 8:00 (2); 8:12, 8:30, 9:00, 9:30, 10:10
Pituophis s. affinis	6:30, 6:45, 7:00, 7:43, 9:50, 10:15
Lampropeltis g. californiae	7:00, 8:15, 8:23, 8:30*, 8:33, 9:37, 9:45, 10:23, 11:15
Lampropeltis g. yumensis	7:58
Sonora m. linearis	7:32
Chilomeniscus cinctus	8:30
Hypsiglena ochrorhynchus	7:40, 8:08, 9:00, 9:05, 10:56, 10:59, 11:14, 11:20, 11:46, 12:10, 12:45 A.M.
Thamnophis marcianus	7:25, 8:03, 8:04, 9:00
Tantilla eiseni	8:10
Trimorphodon vandenburghi	8:10, 9:15, 9:55, 12:30 A.M.
Crotalus cinereous	9:55, 11:00
Crotalus ruber	6:40, 7:25, 7:55, 10:20, 11:30, 3:20 A.M.†
Crotalus scutulatus	7:59, 8:13, 8:55, 9:50, 10:30, 11:37
Crotalus v. oreganus (S. end San Joaquin Valley)	8:45, 10:21
Crotalus m. pyrrhus	7:33

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* Striped phase; all others ringed. † Last one off the road; all others on the road.

TABLE 10.

VARIATION OF ACTIVITY WITH TEMPERATURE

(Number of snakes encountered alive on desert roads at night for each 2-degree rise in air temperature)

Temperature Degrees F.	*Phyllorhynchus decurtatus perkinsi*	*Arizona elegans occidentalis*	*Rhinocheilus lecontei*	*Sonora occipitalis*	*Crotalus cerastes*	*Total*
60-1	....	1	....	....	....	1
62-3	....	....	1	....	1	2
64-5	....	1	1	2	....	4
66-7	2	....	2	....	1	5
68-9	2	....	....	1	1	4
70-1	2	1	3	1	....	7
72-3	3	3	1	...	1	8
74-5	6	3	2	3	2	16
76-7	1	2	2	3	1	9
78-9	4	2	1	4	3	14
80-1	3	6	2	10	2	23
82-3	2	2	2	3	....	9
84-5	4	3	....	3	1	11
86-7	6	2	1	5	1	15
88-9	12	3	....	5	4	24
90-1	6	3	....	....	1	10
92-3	3	....	....	3	....	6
94-5	2	....	....	....	1	3
96-7	....	....	....	....	....	....
98-9	....	....	....	....	1	1
Total	58	32	18	43	21	172

OPTIMUM TEMPERATURE

Tables 10 and 11 show such data as have been accumulated on the air temperatures at times when snakes have been found active on the desert roads at night. An optimum is indicated between 80 and 89 deg. F. It will be observed that the drop is very much steeper above 90° than it is below 80°. While this may be due in part to the relatively small amount of collecting which we have done on hot summer nights, it is not entirely so. As I have stated in discussing the results of example hunting trips, we are continually impressed with the fact that snakes are likely to be active on cold nights during their time of maximum activity in the spring in spite of unfavorable weather; whereas they are relatively inactive in the summer even during an onset of unusually favorable (i. e. cool) weather.

TABLE 11.

TEMPERATURES AT WHICH SNAKES HAVE BEEN OBSERVED ALIVE ON DESERT ROADS AT NIGHT

(All temperatures in degrees Fahrenheit. For five most plentiful species see Table 10)

Leptotyphlops h. cahuilae	64, 88
Lichanura r. roseofusca	73
Phyllorhynchus d. decurtatus	84
Phyllorhynchus browni	84, 86
Pituophis c. deserticola	77, 86, 91
Pituophis s. affinis	69, 84, 85
Lampropeltis g. californiae	70, 76
Lampropeltis g. yumensis	84
Chilomeniscus cinctus	88
Hypsiglena ochrorhynchus	62, 69, 78, 80
Thamnophis marcianus	78, 84, 84, 88
Trimorphodon vandenburghi	66
Crotalus cinereous	82, 88
Crotalus ruber	64, 80, 85, 86
Crotalus scutulatus	63, 76, 76, 80, 80
Crotalus m. pyrrhus	78, 82, 82

With respect to species differences it would seem that the typically Lower Sonoran forms, *P. d. perkinsi, S. occipitalis,* and *C. cerastes,* remain active at a somewhat higher temperature than *A. e. occidentalis* and *R. lecontei.* At the other end of the scale, while there is evidence that the two latter are active at a lower temperature than *S. occipitalis* and *P. d. perkinsi,* this cannot be said of *C. cerastes,* which, in spite of the nature of its normal habitat, seems to be occasionally active in quite cold weather. Possibly this is because the sidewinder is partly a mammal feeder, which is true of neither *S. occipitalis* nor *P. d. perkinsi.*

EFFECT OF MOONLIGHT

Those who have tried collecting at night on the desert are of the opinion that the best results are secured in the dark of the moon. There are so many other variables of season, temperature, wind, humidity, etc. that it is difficult to verify this statistically. In order to eliminate as many variables as possible I have taken the results of night hunts in the Borego area only, further restricted to the months of May and June. We have the following records:

Character of moon	Miles	Live Snakes	Snakes per 100 Miles
Dark	1,084	149	13.7
⅓ to ⅔ full	257	34	13.2
Full moon	214	20	9.4

While these figures indicate some reduction in snake activity on nights of bright moonlight, I do not consider the original data extensive enough to be conclusive. Also it is to be remembered that small snakes are not as easily seen in bright moonlight as in the dark of the moon, since they contrast less with the road background when the headlights of the car pick them up, especially when on the shoulders of the road.

EFFECT OF IRRIGATION IN THE DESERT

In order to ascertain the effects of irrigation and cultivation in a desert area on the herpetological population, I have prepared a statistical summary of the snakes seen on the road in Imperial County, segregated between the irrigated section known as the Imperial Valley, and the surrounding primitive desert. The mountainous and rocky areas in the northeastern and southwestern corners of Imperial County have been omitted from consideration, since it is undesirable to complicate the statistics with species which do not occur on a level plain, whether barren or cultivated. The irrigated section takes in the central portion of the county from Niland on the north to Calexico on the south; and from Date City on the east to Dixieland to the west; it covers about 600,000 acres.* Here we have, in the center of one of the most barren desert areas of the southwest, an intensively cultivated section of orchards, vineyards, grain and alfalfa fields, and truck gardens. The irrigation project began in 1900; it has been intensively developed and utilized for the past 35 years and whatever changes have been effected in the fauna have taken place within that time.

Originally all of the area now irrigated was not of precisely the same character as the rest of the desert, since it contained several small shallow lakes filled almost annually by some of the overflow channels coming back to the north out of the Colorado River delta. Thus in a few isolated places there may have been present at that time some of the Colorado River amphibians and reptiles. But over most of the desert the fauna must then have been what it still is today, beyond the limits of the cultivated area.

Table 12 summarizes the results of some 61 trips into or through this area during the past 13 years. The mileage involved was 1888 in irrigated and 2834 in primitive territory. In order to equalize this difference we present the results in the two final columns on a mileage basis. It should be understood that the figures indicate all snakes recorded, whether alive or DOR, and whether noted on day or night trips.

We find from our data that snakes are somewhat more than twice as plentiful in the irrigated as compared to the primitive territory. Much of the increase is accounted for by two species: the red racer, *C. f. frenatum,* which is almost exclusively diurnal; and the desert gopher snake, *P. c. deserticola,* which is diurnal in the spring and autumn, but is largely nocturnal in summer.

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*See Map 3, Bulletin No. 8 of this series.

TABLE 12.

EFFECT OF IRRIGATION AND CULTIVATION ON A SNAKE POPULATION
(Imperial County, California; valley floor areas only)

	Specimens		Snakes per 100 Miles	
	Irrigated area	Non-irrigated area	Irrigated area	Non-irrigated area
C. f. frenatum	22	2	1.16	0.07
S. g. hexalepis	6	3	0.32	0.11
P. d. perkinsi	..	5	....	0.18
A. e. occidentalis	8	7	0.42	0.25
P. c. deserticola	104	8	5.50	0.28
L. g. yumensis	3	....	0.16	....
R. lecontei	4	1	0.21	0.04
S. occipitalis	....	21	....	0.74
S. m. linearis	2	....	0.11	....
T. marcianus	7	....	0.37	....
C. cinereous	1	1	0.05	0.04
C. cerastes	1	39	0.05	1.38
Total	158	87	8.35	3.09

Our twelve species of snakes fall rather readily into four classes:

1. Present in irrigated areas; absent in dry areas
    L. g. yumensis
    S. miniata linearis
    T. marcianus
2. Strong preference for irrigated areas
    C. f. frenatum
    P. c. deserticola
3. Present in both areas with a somewhat increased prevalence in irrigated areas
    S. g. hexalepis
    A. e. occidentalis
    R. lecontei
    C. cinereous
4. Absent or virtually absent from irrigated areas
    P. d. perkinsi
    S. occipitalis
    C. cerastes

Class 1 comprises importations from the Colorado River. It is not known whether they were present about the scattered shallow lakes that were occasionally filled from the river overflow in pre-irrigation times. If present at all they were much rarer than now, since the collectors of those days did not secure any. *S. m. linearis* is today a more common species than this table would indicate. It is small and very secretive, and therefore is seldom seen on the road. Presumably a feeder on worms and insects, it would naturally increase with the increase in its food supply following cultivation. *T. marcianus*, preying largely, if not entirely, on frogs and toads, has likewise had its food supply greatly increased by the coming of irrigation.

The second group contains two large snakes which prey on rodents, although the red racer also feeds on snakes and lizards. With the increased availability of small mammals, following cultivation, the prevalence of these snakes has correspondingly increased. They are quite typically desert forms—that is, they are occasionally found in the most barren situations; and they were present in the Imperial Valley long before the advent of irrigation. But it is evident that they have found the new conditions to their liking and have increased greatly in numbers; they are certainly much more plentiful today in the newly irrigated area than in any primitive, barren section, whether in Imperial County, or elsewhere in the southwestern deserts.

Group 3 have had their status moderately improved by cultivation. The first three are partly lizard feeders; but while this prey (particularly certain species) has been greatly reduced by irrigation, the difference is more than made up by the increase in rodents. It is interesting to note that the same result has been produced on one diurnal snake (*S. g. hexalepis*) and two which are nocturnal (*A. e. occidentalis* and *R. lecontei*). These three forms are species which are both Upper and Lower Sonoran in range. *C. cinereous* is not particularly common in Imperial County and we have insufficient data here to prove anything concerning the effect of irrigation on its activities. In primitive areas its preferred habitat is sandy mesquite hummocks; and in the Coachella Valley, Riverside County, California, it seems to be more prevalent in the primitive sections than in the adjacent date groves or alfalfa fields.

The last group is made up of the most typical of all the desert forms; their ranges are wholly Lower Sonoran. They seem unable to accommodate themselves to the new conditions involved in irrigation and cultivation. The first two are almost exclusively lizard-eaters and they no doubt suffer from the diminution in their food supply. *C. cerastes*, while feeding on both lizards and rodents, is evidently unable to withstand the moisture which is usually absent in the natural habitat of this most highly specialized of our desert snakes. So we see that these denizens of the more barren areas of the desert are driven out by the change in habitat resulting from irrigation and cultivation. Incidentally it will be noted from Table 12 that *S. occipitalis* is commoner in the Imperial area than *P. d. perkinsi*, while the contrary is true on the Borego road (Table 5). *S. occipitalis* prefers sandy flats or hummocks, while *P. d. perkinsi* is commonest in a brushy or gravelly desert. The latter is characteristic of Borego.

In summary we see that in this large irrigation project, cultivation has resulted in a great increase in two large harmless snakes, one of which is

TABLE 13.

Ecological Conditions of Roadsides Where Snakes Have Been Found

(Southern California and southwestern Arizona only)

	Pond, Creek, or River Bank	Orchard or Vineyard	Cultivated Field	Grass	Light Brush	Heavy Brush, Chaparral	Trees, Forest	Rocks, Boulders	Rocky Desert	Brushy Desert	Sandy Desert	Barren Desert	Total
L. r. roseofusca....	1	...	4	3	1	11	.	10	...	1			31
C. c. mormon......	1	1	4	9	1	....	1		....	....		.	17
C. f. frenatum......	5	8	59	57	20	9	....	7	1	20	12	5	203
C. lateralis...........			4	28	4	52	.			.			88
S. g. hexalepis		..	5	1	....	....	.	....	3	13	5	3	30
S. g. virgultea	4	3	1	3	4	35	3	9	.		..	....	62
P. d. perkinsi.......	.	.	1	....	....	....	. .	...	21	112	10	66	210
A. e. occidentalis..	..	2	18	13	4	8	....	4	4	25	22	15	115
P. c. annectens......	8	23	73	78	10	58	18	14					282
*P. c. deserticola**..		7	104	42	....	....	. .		17	54	6	4	234
L. g. californiae (striped).......	2	3	11	30	1	6		1				.	54
L. g. californiae (ringed) ...	3	6	19	60	4	15	.	2	. .	1		.	110
R. lecontei	1	4	7	30	8	32		19	1	19	1	2	124
S. occipitalis	..		....	....	....	....	. . .	...	2	32	47	53	134
H. ochrorhynchus	..	....	....	....	....	2	.	6	6	1	.		15
T. o. hammondii..	30	1	2	26	2	5	1			...	..		67
C. cerastes	.		1	...	.	. .			2	16	15	26	60
C. ruber	2		2	3	1	22		5		6	.		41
C. m. pyrrhus......	1	...	.	1	1	3		8				1	15
C. v. oreganus......		1	7	22	3	14	4	2			...	...	53
Total	58	59	322	406	64	272	27	87	57	300	118	175	1945

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* Includes *P. s. affinis*

almost exclusively, and the other largely predatory on rodents. For this the farmers should be grateful; the snakes are not only their allies, but, being harmless, are without the objectionable venomous quality possessed by rattlers, which causes the latter to be the object of extermination campaigns in some areas. The small desert snakes which have been driven out are probably not economically important; besides their places have been taken by other importations from the river banks, although one of these, the garter snake, is objectionable. The increase of the amphibians is highly beneficial. While the lizards are reduced in number by cultivation, and those which are typically denizens of Lower Sonoran sandy areas, such as *Dipso-saurus dorsalis dorsalis, Uma notata,* and *Callisaurus ventralis gabbii,* are practically driven out, others, which are also found in the Upper Sonoran Zone, such as *Cnemidophorus tessellatus* and *Uta stansburiana,* not only survive, but may actually increase, with beneficial effects on insect control. *Sceloporus magister* is another species whose status is improved by cultivation, since trees and large shrubs constitute a preferred habitat.

ECOLOGICAL STATISTICS

For some years past I have made a practice of noting the character of the habitat bordering the road when a live or dead snake has been found thereon. With respect to some species there have now been accumulated sufficient data to indicate certain definite preferences. Of course the classification of habitats has necessitated some rather arbitrary grouping to avoid too many slightly differing classes.

Table 13 presents the results for the twenty most prevalent species, whether on the coastal or desert side of the mountains; however to avoid the complications of territorial differences only southern California and southwestern Arizona specimens are included.

Table 14 sets forth miscellaneous data of the same character for various species, of which the observations were not available in sufficient numbers to warrant inclusion in the previous table.

While these two tables serve largely to verify previous knowledge respecting the preferred habitats of the various species, a few deserve particular comment. We note, for example, that while the red racer, *C. f. frenatum,* is mainly a tenant of the open fields and grasslands, the striped racer *C. lateralis,* prefers chaparral, as does also the coastal patch-nosed snake, *S. g. virgultea.* The western yellow-bellied racer, *C. c. mormon,* prefers fields, or, on this southern border of its range, mountain meadows.

The gopher snakes, *Pituophis,* are likely to be found everywhere, but are especially prevalent in cultivated areas and about human habitations where their rodent prey is present in greatest numbers. The same is true of the king snakes.

The garter snakes prefer grass, or, more especially, the banks of streams and ponds; but, as these tables are based on roadside specimens, they do not indicate this preference to an adequate extent, since they are largely made up of individuals en route between such areas.

TABLE 14.

ECOLOGICAL CONDITIONS OF ROADSIDES WHERE SNAKES HAVE BEEN FOUND

(Less plentiful species; figures in parentheses indicate number of specimens found in each habitat.)

Leptotyphlops humilis	Brush (2), rocks (3), rocky desert (11)
Lichanura r. gracia	Brushy desert (2)
Coluber piceus	Grass (2)
Coluber t. taeniatus	Cultivated field (2), grass (4), light brush (10), chaparral (5), trees (2), rocks (1)
Phyllorhynchus browni	Brushy desert or mesquite (5), cactus (1)
Phyllorhynchus d. decuratus	Mesquite (2), city street (1)
*Pituophis c. catenifer**	Orchard and vineyard (5), cultivated field (23), grass (21), light brush (1), chaparral (4), trees (3), rocks (1)
Lampropeltis g. yumensis	Cultivated field (4)
Sonora m. linearis	Cultivated field (3)
Thamnophis s. infernalis	Creek (3), marsh (3), orchard (1), garden (1), cultivated field (2), grass (5), chaparral (1)
Thamnophis o. vagrans	Cultivated field (1), grass (4), rocks (1)
Thamnophis marcianus	Cultivated field (6)
Trimorphodon lyrophanes	Creek (1), orchard (1), light brush (1)
Trimorphodon vandenburghi	Orchard (1), grass (1), chaparral (2), rocks (4), rocky desert (4)
Crotalus cinereous	Brushy desert (4)
Crotalus scutulatus	Orchard (1), grass (2), brushy desert (6), barren desert (1)
Crotalus v. nuntius	Grass (2)
Crotalus v. lutosus	Cultivated field (1), grass (1), chaparral (1)

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* Includes *P. c. heermannii.*

TABLE 15.

Distribution of Reptiles and Plants Along the Borego Road

	Scissors Crossing Semidesert Valley 0.0 mi. 2,400 ft.	Sentenac Canyon Bridge Rocky Canyon—Water 2.8 mi. 1,600 ft.	Yaqui Well Sandy Dry Wash 6.0 mi. 1,270 ft.	The Narrows Rocky Dry Canyon 11.7 mi. 1,100 ft.	Mesa Grande Brushy Desert 13.6 mi. 880 ft.	Benson's (Ocotillo) Gravelled Desert 21.3 mi. 165 ft.	County Line Barren Desert 24.3 mi. 85 ft.
Lizards							
Phyllodactylus tuberculosus		x	x	x			
Coleonyx variegatus	x	x	x	x	x	x	x
Dipso-saurus dorsalis dorsalis			x	x	x	x	x
Crotaphytus collaris baileyi		x	x	x			
Crotaphytus wislizenii			x	x	x	x	x
Sauromalus obesus		x	x	x			
Callisaurus ventralis gabbii			x	x	x	x	x
Uma notata						x*	
Uta graciosa			x		x	x	x
Uta mearnsi		x		x			
Uta stansburiana stejnegeri	x	x	x	x	x	x	x
Sceloporus magister		x	x	x			
Sceloporus occidentalis bi-seriatus	x						
Sceloporus orcutti	x	x					
Phrynosoma blainvillii blainvillii	x						
Phrynosoma m'callii						x	x
Phrynosoma platyrhinos platyrhinos			x	x	x	x	x
Gerrhonotus multi-carinatus webbii	x						
Anniella pulchra	x	x	x	x			
Xantusia henshawi		x		x			
Xantusia vigilis	x		x				
Cnemidophorus tessellatus tessellatus	x		x	x	x	x	x
Eumeces skiltonianus skiltonianus	x						
Snakes							
Leptotyphlops humilis humilis		x					
Leptotyphlops humilis cahuilae		x	x	x			
Lichanura roseofusca roseofusca	x	x	x	x			
Coluber flagellum frenatum	x	x	x	x	x	x	
Coluber lateralis	x						
Salvadora grahamiae hexalepis					x	x	x
Phyllorhynchus decurtatus perkinsi	x	x	x	x	x	x	x
Arizona elegans occidentalis	x	x	x	x	x	x	x
Pituophis catenifer annectens	x	x					
Pituophis catenifer deserticola	x		x		x	x	x
Lampropeltis getulus californiae (striped)	x	x	x				
Lampropeltis getulus californiae (ringed)	x	x	x	x	x	x	
Rhinocheilus lecontei	x	x	x	x	x	x	x
Sonora occipitalis			x	x	x	x	x
Hypsiglena ochrorhynchus		x	x	x			
Thamnophis ordinoides hammondii	x	x					
Tantilla eiseni		x	x				
Trimorphodon vandenburghi		x		x			
Crotalus ruber	x	x	x	x			
Crotalus mitchellii pyrrhus		x	x	x			
Crotalus viridis oreganus	x						
Crotalus cerastes			x	x	x	x	x
Plants							
Juniperus californicus		x					
Ephedra nevadensis		x					
Hilaria rigida							x
Yucca mohavensis	x						
Agave deserti		x	x	x			
Eriogonum W. var. *membranaceum*		x					
Atriplex lentiformis				x		x	
Atriplex hymenelytra							x
Isomeris arborea		x					
Acacia Greggii	x		x				
Prosopis chilensis	x						
Krameria Grayi						x	
Dalea Schottii var. *puberula*					x		
Dalea spinosa			x	x			
Olneya Tesota			x	x			
Larrea divaricata	x		x	x	x	x	x
Croton californicus	x						
Simmondsia chinensis		x	x				
Fouquieria splendens			x	x	x	x	x
Petalonyx Thurberi				x			
Opuntia Bigelovii		x	x		x		
Opuntia echinocarpa			x		x		
Opuntia basilaris		x		x			
Cereus Engelmannii			x				
Echinocactus acanthodes		x		x			
Heliotropium Curassavicum var. *oculatum*	x						
Salvia apiana var. *compacta*		x					
Hyptis Emoryi			x				
Chilopsis linearis	x		x	x			
Beloperone californica			x				
Gutierrezia californica		x					
Aplopappus venetus var.?	x						
Hymenoclea Salsola	x			x	x	x	
Franseria dumosa			x	x		x	x
Encelia farinosa			x	x			
Trixis californica		x					

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* In sand dunes off the road.

TABLE 16.

Sixteen Year Census of Snakes of San Diego County, California, 1923-1938*

Distribution by Months.

Species	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total	Rank	Per Cent
L. h. humilis	4	4	4	7	17	19	13	9	5	2	2	2	88	19	0.68
L. h. cahuilae	....	....	...	2	12	1	2	1	1	...	...	1	20	24	0.15
L. r. roseofusca	1	3	32	92	109	140	31	13	10	15	8	4	458	9	3.54
D. a. similis	14	47	84	91	80	40	32	23	28	23	16	13	491	8	3.79
D. a. modestus	....	....	....	....	1	....	....	....	....	....	...	..	1	30	0.01
C. c. mormon	....	2	4	11	21	26	11	4	2	....	1	..	82	20	0.64
C. f. frenatum	....	1	11	37	132	96	35	11	21	6	1	....	351	10	2.71
C. piceus	....	....	....	1	1	1	....	....	1	..	....	....	4	27	0.03
C. lateralis	2	5	26	146	187	91	55	29	29	11	5	3	589	7	4.55
S. g. virgultea	....	....	5	35	53	49	24	7	8	2	2	1	186	15	1.44
S. g. hexalepis	....	....	1	....	1	....	....	...	....	..	....	....	2	28	0.02
P. d. perkinsi	....	....	5	23	106	91	31	15	17	1	....	....	289	13	2.23
A. e. occidentalis	....	1	1	17	51	54	7	6	6	2	..	..	145	18	1.12
P. c. annectens	21	50	194	484	764	602	160	63	89	103	38	23	2591	1	20.01
P. c. deserticola	....	....	....	1	5	1	2	....	3	1	....	....	13	26	0.10
L. g. californiae (striped)	3	7	21	108	190	176	109	60	34	10	4	3	725	6	5.60
L. g. californiae (ringed)	8	12	37	133	303	256	173	76	48	20	10	1	1077	4	8.32
L. multicincta	1	...	....	1	8	16	12	10	1	1	....	....	50	21	0.39
R. lecontei	2	1	9	34	125	72	34	17	11	3	1	2	311	12	2.40
S. occipitalis	5	2	5	21	114	45	15	8	3	3	3	....	224	14	1.73
S. m. linearis	...	....	....	1	....	....	....	....	....	....	....	....	1	30	0.01
H. ochrorhynchus	6	7	18	19	35	22	11	19	8	5	3	4	157	16	1.21
T. s. infernalis	....	1	5	1	10	1	....	2	....	....	....	....	20	24	0.15
T. o. hammondii	5	32	169	389	507	520	394	97	68	32	15	2	2230	2	17.22
T. eiseni	..	4	2	3	12	12	6	1	2	1	1	1	45	22	0.35
T. vandenburghi	1	1	5	10	13	3	3	3	2	2	....	1	44	23	0.34
C. cinereous	....	..	....	2	....	....	....	....	....	....	....	....	2	28	0.02
C. cerastes		1	2	29	64	23	16	...	10	5	1	....	151	17	1.17
C. ruber	10	20	110	273	182	132	89	77	51	44	17	8	1013	5	7.82
C. m. pyrrhus	..	1	12	39	77	85	41	39	21	2	1	11	329	11	2.54
C. v. oreganus	11	19	125	223	251	184	125	108	88	81	26	17	1258	3	9.71
Total	94	221	887	2233	3431	2758	1431	698	567	375	155	97	12947	...	..
Per Cent of Total	0.73	1.71	6.85	17.25	26.49	21.30	11.05	5.39	4.38	2.90	1.20	0.75			100.00

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* Compiled from the records of specimens presented to the Zoological Society of San Diego, the San Diego Society of Natural History, and field trips of the writer and his friends and associates, especially the members of the San Diego Reptile Club.

The rock dwellers are *Leptotyphlops, Hypsiglena,* and *Trimorphodon;* and, of the rattlers, *C. m. pyrrhus* and *C. m. stephensi.* This again is not adequately made clear from these roadside statistics.

It is of interest to observe that *C. v. oreganus* is most often found in fields or grass, while *C. ruber* prefers chaparral; it also often occurs in cactus or amongst granite boulders.

Our most intensive ecological study has been made on the Borego road, the 376 live specimens collected there being listed in Table 5. In addition 102 DOR specimens were recorded on this 24-mile stretch of highway. As has been previously stated, this road has been selected because it is the nearest desert stretch to San Diego and has been found a prolific source of snakes. It furnishes a particularly favorable sample of the lower desert foothills and the western edge of the desert itself.

On this road, starting at Scissors Crossing (alt. 2400 ft.) in the San Felipe Valley, one proceeds for a mile along the eastern edge of the valley and then descends into Sentenac Canyon. Here one follows a winding road, bordered on one side by a barren, boulder strewn hillside, and on the other by a small perpetual stream. Four miles from the starting point, the canyon emerges out into the San Felipe Wash. Here the water sinks and the road turns eastward, following the barren, sandy wash, past Yaqui Well (6 mi.)* to a rocky cleft in the mountains known as The Narrows (11.7 mi.). Issuing through this the wash broadens out and the road turns away to follow higher, level land (the Mesa Grande); this is somewhat sandy or stony, but with a good brush cover, which gradually decreases as the road goes eastward. We then pass Benson's Dry Lake Service Station or Ocotillo (21.3). East of this point the vegetation thins out rapidly, the plants becoming both smaller and more widely spaced, and we usually terminate our hunts at the San Diego-Imperial County line distant 24.3 miles from our starting point as Scissors Crossing, having descended from an altitude of 2400 ft. to 84 ft. above sea level.

In Table 15 I have attempted to correlate the snake population with data on the plants, the latter kindly furnished by Mr. Frank F. Gander, of the San Diego Natural History Museum. For this purpose I have indicated the species to be found at seven typical stations along this desert foothill and desert plain road.

In this table we see the gradual change from the forms which are characteristic of the desert mountains and foothills, to those which inhabit the sandy and gravelly level areas. Some of those which fall out along the route are coastal forms which cannot withstand the true desert (e. g. *Pituophis c. annectens, Coluber lateralis*); others are rock dwellers which are absent because of the lack of this habitat (e. g. *H. ochrorhynchus, C. m. pyrrhus*), but which are found again further east when suitable rocky mountains recur.

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*Distance from starting point at Scissors Crossing.

TABLE 17.

SIXTEEN YEAR CENSUS OF SNAKES OF SAN DIEGO COUNTY, 1923-1938

Distribution by Zones*

Species	Coast	Inland Valleys	Foothills	Mountains	Desert Foothills	Desert	Undetermined	Total
L. h. humilis	38	15	25	2	8	...	...	88
L. h. cahuilae	...	...	...	...	18	2	...	20
L. r. roseofusca	50	157	176	2	71	2	...	458
D. a. similis	395	54	29	9	...		4	491
D. a. modestus	1	...	...		...			1
C. c. mormon	15	23	24	18	2			82
C. f. frenatum	112	84	34	...	98	23		351
C. piceus	1	...	3	...	...	...		4
C. lateralis	165	147	216	19	35	...	7	589
S. g. virgultea	14	39	117	2	13	...	1	186
S. g. hexalepis	...	...	...	...	...	2		2
P. d. perkinsi	...	...	...	...	97	192		289
A. e. occidentalis	30	9	9	...	48	49		145
P. c. annectens	1083	692	673	71	55	...	17	2591
P. c. deserticola	...	...	...	...	3	10	...	13
L. g. californiae (striped)	357	211	137	14	5	...	1	725
L. g. californiae (ringed)	511	330	160	19	40	9	8	1077
L. multicincta	...	...	3	47	...	...	...	50
R. lecontei	116	81	60	1	35	15	3	311
S. occipitalis	...	...	...	...	80	144	...	224
S. m. linearis	...	...	...	...	...	1	...	1
H. ochrorhynchus	67	21	36	3	27	1	2	157
T. s. infernalis	4	16	...	...	...	...	...	20
T. o. hammondii	451	655	929	144	45	2	4	2230
T. eiseni	21	12	7	1	4	...	...	45
T. vandenburghi	1	11	18	...	14	...	...	44
C. cinereous	...	...	...	...		2	...	2
C. cerastes	...	...	...	...	28	123		151
C. ruber	276	354	282	5	84	9	3	1013
C. m. pyrrhus	2	51	199	21	52	3	1	329
C. v. oreganus	456	371	273	78	58	...	22	1258
Total	4166	3333	3410	456	920	589	73	12947
Percent of Total	32.18	25.74	26.34	3.52	7.11	4.55	0.56	100.00

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* For a map delineating these zones see Bull. No. 8, Zool. Soc. of S. D. at p. 8, 1931.

It is interesting to observe that, of the three most typically desert species *C. cerastes*, *S. occipitalis*, and *P. d. perkinsi*, only the last has been able to penetrate up the Sentenac Canyon and gain a foothold in San Felipe Valley. Similarly in other parts of the southwestern desert the leaf-nosed snake ranges over a somewhat greater territory and through a wider diversity of ecological conditions than the other two, although *C. cerastes* has reached southwestern Utah, where *P. d. perkinsi* has not been taken.

The intensive collecting along the Borego road does not yet seem to have caused a diminution in the supply of snakes. No doubt it will eventually, for every herpetologist in southern California and visitors as well, work the road at frequent intervals. However it must be remembered that the normal traffic is light and probably the snake hunters capture fewer specimens than are killed by cars on heavily traveled roads. For on such roads destruction operates without cessation at all hours and in all seasons. In 1930 I calculated the destruction of snakes in San Diego County by automobiles at 10,000 per annum. Probably it remains at this figure today, for although the autos in the county now exceed 100,000 and operate more than 2 million miles per day (a considerable proportion urban) the snakes immediately contiguous to the heavily traveled highways have been already decreased so as to reduce the casualties per traffic mile. Fortunately for the future herpetologist there are many primitive areas both of chaparral and desert into which these roads do not penetrate. In the brush lands the greatest danger to the small animals is from fire, and fire prevention methods and equipment have improved notably during the past eight years.

SNAKE CENSUS IN SAN DIEGO COUNTY

In its scope the statistical section of the present paper may be considered as supplemental to a former publication entitled "A Statistical Survey of the Snakes of the Southern Border of California" which appeared in 1931.* Although, in the intervening years, additional records have been accumulated which would considerably expand the tables appearing in the previous paper, it is not deemed expedient to include such revised tables in the present discussion. However, four of the old tables are thought to warrant revision with the new material included. In 1931 there was not available in San Diego County a stretch of road suitable for collecting the desert forms and therefore these were inadequately represented in the prior statistics. This condition has been remedied by the completion of the Borego road, so that a more representative picture may now be afforded by the records. Hence I present in Table 16 a census, by months, of the snakes of San Diego County which corresponds to Table 1 of the previous paper: Table 17 is the same census on a zonal basis corresponding to old Table 3; and Tables 18 and 19 correspond to old Tables 5 and 6, except that they are now extended to include night trips, in order to compare the diurnal with the nocturnal activities of the snakes.

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*Bull. Zool. Soc. of San Diego, No. 8, pp. 1-93, figs. 1-8.

TABLE 18.

SNAKES ENCOUNTERED ON THE ROAD IN SAN DIEGO COUNTY

	Daylight Travel Coast to Desert Inclusive, 49,418 Miles			Night Travel Desert Only 2,985 Miles		
Species	Alive	Dead	Total	Alive	Dead	Total
Leptotyphlops humilis humilis	...	2	2	2	...	2
Leptotyphlops humilis cahuilae	...		.	6	6	12
Lichanura roseofusca roseofusca	8	25	33	5	1	6
Diadophis amabilis similis	..	1	1	....	....	....
Coluber constrictor mormon	2	16	18	....	....	....
Coluber flagellum frenatum	6	102	108	1	7	8
Coluber piceus	....	1	1	....	....	....
Coluber lateralis	26	149	175	....	....	....
Salvadora grahamiae virgultea	5	56	61	....	....	....
Salvadora grahamiae hexalepis	..	...	..	....	....	....
Phyllorhynchus decurtatus perkinsi	..	4	4	110	35	145
Arizona elegans occidentalis	....	29	29	32	5	37
Pituophis catenifer annectens	42	502	544	...	....	....
Pituophis catenifer deserticola	..	....	....	1	....	1
*Lampropeltis getulus californiae**	5	77	82	1	1	2
Lampropeltis getulus californiae†	8	119	127	3	....	3
Lampropeltis multicincta	....	....	....	....	....	....
Rhinocheilus lecontei	1	116	117	13	3	16
Sonora occipitalis	....	....	....	64	23	87
Sonora miniata linearis	....	....	....	..	..	....
Hypsiglena ochrorhynchus	...	4	4	8	1	9
Thamnophis sirtalis infernalis	....	8	8	...	...	...
Thamnophis ordinoides hammondii	10	91	101	1	...	1
Tantilla eiseni	....	....	...	1	....	1
Trimorphodon vandenburghi	....	9	9	4	2	6
Crotalus cinereous	....	....	....	..	....	....
Crotalus cerastes	....	1	1	21	4	25
Crotalus ruber	6	40	46	4	1	5
Crotalus mitchellii pyrrhus	2	9	11	...	1	1
Crotalus viridis oreganus	8	69	77	....	....	....
Unidentified	11	31	42	2	....	2
Total	140	1461	1601	279	90	369

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* Striped Phase † Ringed Phase.

It is not my intention to repeat the discussions of results contained in the previous paper. Rather I shall touch only on the points which are exemplified or emphasized by the expanded material. For a detailed discussion of such matters as variations in activity of snakes with different centers of dispersal, pattern and color variations with habitat, the correlation of speed and pattern, the percentage of juveniles, and the ratio of dead to live snakes encountered on the road, the reader is directed to the former paper.

Table 16 now includes a sixteen year record of the snakes reported from San Diego County with a total of 12,947 specimens.[*] It probably gives a fairly accurate picture of the frequency of occurrence of the snakes in this area and their seasonal distribution. The desert night forms are now fairly well represented, since, in recent years, we have concentrated on the type of road collecting discussed in the first part of this paper.

Thamnophis ordinoides elegans, which was listed in the prior table, was so included on erroneous locality information; it is not known to occur south of the San Bernardino Mountains.

One of the interesting features of this table is the evidence that none of these species is really rare; if any are present in small numbers, say less than 100 specimens, the reason is to be found under one of two heads: (1) San Diego County comprises an edge of the range, so that they inhabit only a small portion of the territory or tend to thin out where they are found, or (2) they are secretive and are therefore seldom found abroad. The outstanding examples of these two groups are:

Range Edge Forms
- *C. c. mormon*
- *C. piceus*
- *D. a. modestus*
- *S. g. hexalepis*
- *P. c. deserticola*
- *L. multicincta*[†]
- *S. m. linearis*
- *T. s. infernalis*
- *C. cinereous*

Small Secretive Forms
- *L. h. humilis*
- *L. h. cahuilae*
- *T. eiseni*
- *T. vandenburghi*

Several of the the first group barely enter the county at all, this being true of *D. a. modestus, C. piceus, S. m. linearis,* and *C. cinereous.* These snakes are all known to be quite plentiful in other areas beyond the county confines.

I think that the secretive forms of Group 2 must actually be exceedingly common, but their habits are such as to make them difficult to secure. The first three are nocturnal snakes of very small size; although it is known that they spend some time on the ground surface at night, they are so difficult to see that many must be overlooked when driving, and no doubt they prefer to remain close to the rocks and debris under which they

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[*] For the sources of these records see p. 2 of the prior paper.

[†] Range in San Diego County limited to mountain peaks.

TABLE 19.

SEASONAL DISTRIBUTION OF SNAKES ENCOUNTERED ON THE ROAD IN SAN DIEGO COUNTY

	Daylight Travel, Coast to Desert, Inclusive 49,418 Miles						Night Travel, Desert Only 2,985 Miles					
Month	Miles	Live Snakes	Dead Snakes	Total Snakes	Live Snakes per 100 Miles	Total Snakes per 100 Miles	Miles	Live Snakes	Dead Snakes	Total Snakes	Live Snakes per 100 Miles	Total Snakes per 100 Miles
January	1,119	....	2	2	0.00	0.18	....	....	....	....	....	....
February	2,002	....	9	9	0.00	0.45	....	....	....	....	....	....
March	5,647	2	100	102	0.04	1.81	43		....	....	0.00	0.00
April	8,404	19	295	314	0.23	3.74	279	28	6	34	10.0	12.2
May	12,041	53	602	655	0.44	5.44	1,076	130	51	181	12.1	16.8
June	7,168	41	302	343	0.57	4.78	449	78	17	95	17.4	21.2
July	4,299	21	80	101	0.49	2.35	354	10	10	20	2.8	5.6
August	2,378	3	21	24	0.13	1.01	213	12	1	13	5.6	6.1
September	1,994	3	42	45	0.15	2.26	469	19	5	24	4.1	5.1
October	1,836	1	14	15	0.05	0.82	97	2		2	2.1	2.1
November	1,425	....	4	4	0.00	0.28						
December	1,105	....	1	1	0.00	0.09				....	....	....
Total	49,418	143	1,472	1,615	0.29	3.27	2,985	279	90	369	9.3	12.4

hide in the daytime. As to *Trimorphodon*, it is so largely a rock dweller that it is likely to be found only by prying off flakes or cap rocks, or at night along the limited stretches of road which are bordered by boulders or cliffs.

No attempt should be made to compare Tables 1 and 3 of the former report with present Tables 16 and 17 in an endeavor to determine differences between snake populations before and after January 1, 1931. Such differences will indeed be found, but they are much more likely to result from the widening and straightening of roads, higher auto speeds, and similar traffic conditions, and in the access of roads to new areas, than to actual changes in the snake population.

A good many seasonal and habitat preferences are evident from Tables 16 and 17. A spring peak of seasonal activity is indicated for every species. This is seen to be earlier in Upper, than in Lower Sonoran forms, since the former are, in their centers of dispersal, more accustomed to moisture and lower temperatures. But mountain species (e. g. *Lampropeltis multicincta*) have late peaks, since their habitat has a late season, even in this southern country.

Tables 18 and 19 supply a comparison between snake populations on the coastal and desert sides of the mountains. They show without question that live snakes are many times more plentiful at night on the desert roads than they are in the daytime on the coastal side of the mountains. Even allowing for the fact that the Borego area is unusually fruitful, compared with other areas, the fact remains that there are no snakes in the coastal areas that are as common either by day or night as are *Phyllorhynchus* and *Sonora* at night on the desert.

Of interest in Table 19 is the ratio of live to dead snakes during the daylight trips (mostly on the coastal side of the mountains), as compared to the same ratio during the night travel, all of which was in the Borego area of the desert. In the former case there was only one live snake encountered to every ten dead ones; in the latter three live snakes to each dead one. Thus there is a total difference of thirty to one. The actual total casualties per mile in the two areas are the same, being 3.01 snakes per 100 miles on the coastal side and 3.02 on the desert. Obviously these figures depend somewhat on the relative monthly mileage distributions of the trips which produced the data; however these distributions are proportionately somewhat similar. The corresponding figures for the month of May alone are 5.01 and 4.74 respectively, showing that the equality still holds substantially during the peak month. With a much greater density of live snakes in the desert area, as compared to the coast (30 to 1), the equality in casualties is to be accounted for by the far greater density of traffic in the coastal area, thus demonstrating once more the intimate relation between DORs and traffic density.

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SUMMARY AND CONCLUSIONS

1. Hunting for reptiles, particularly snakes, at night on the southwestern deserts, by driving slowly on paved roads, has proved more efficient and fruitful than hunting afoot. This method has improved collections, extended known ranges, and provided useful data on reptile habits.

2. Not all roads or areas are equally suited to this kind of collecting. Lightly traveled paved roads are best; heavily traveled highways are to be avoided. Since the density of the snake population varies considerably with the ecology of a territory, only experience will determine the best areas. Auto speed, collecting equipment, and character of records are discussed.

3. The peak of activity of the nocturnal snakes on the desert is about two weeks later than that of the diurnal snakes on the coast, or about May 20 to June 10. It is somewhat affected by local conditions of altitude, wind exposure, etc. An early or late spring also modifies the date. The optimum air temperature seems to be between 80° and 86° F.; however snakes are occasionally found at temperatures as low as 60°. The dark of the moon is probably preferable to a full moon but this cannot be asserted as proven. In the spring nocturnal snakes are active early in the evening and retire when the desert cools off. Later in the summer they may be active all night; however summer activity, even with favorable weather conditions, is less than that of the spring even though the latter may be under unfavorable conditions. Certain species differences are discussed.

4. The best desert collecting is found in areas with a considerable cover of vegetation, extremely barren sections being virtually without reptile life. Some species prefer rocky habitats and consequently can only be collected by driving along roads bordered by rocks.

5. Cultivation and irrigation effect changes in a primitive reptile population. Such changes are investigated by a statistical study in Imperial County.

6. Diurnal lizards are occasionally found active at night. *Coleonyx* is the only lizard which can be more effectively collected by driving than by other methods. Various statistical data on the activities of this lizard are given.

7. Data are presented on the relative day and night activities of snakes, premised on those encountered alive on the highways.

8. A summary of ecological preferences is given, based on the conditions of the roadside where specimens have been found. A special study is made of a 24 mile stretch of desert road in San Diego County.

9. The seasonal and zonal distributions of snakes in San Diego County are presented in tables listing about 13,000 specimens.

PART II.

SPECULATIONS ON PROTECTIVE COLORATION AND PROTECTIVE REFLECTIVITY

Mr. H. W. Parker, in connection with the description of a new melanistic lizard, has lately (Parker, 1935) discussed the value of melanism as a protective condition in certain desert animals. He suggests that animals which can take refuge in sand will be benefited by a light color, since, in their forays for food, their temperatures will be raised less rapidly than would be the case if they were dark; and when they have reached an uncomfortably high temperature, and have taken refuge by burrowing, a black color would be of no service because they then lose heat by conduction. But rock-dwelling forms, on the contrary, are benefited by being dark, since, after their forays, when they take refuge in rock-crevices, they lose heat primarily by radiation, which loss is expedited by the dark color. To quote Parker: "Briefly, it is suggested that under physical and climatic conditions where animals, especially poikilothermic ones, are liable to have their body temperatures raised above the optimum, but where they can escape from direct solar heat-radiation, a black coloration bestows a definite advantage upon its possessor; the better heat dissipating properties of a dark surface as compared with a light one assist the animal in maintaining its temperature below that of its surroundings. Upon arid barren rocks in tropical or subtropical regions, and in the tropical rain forests, melanism is an asset; in sandy deserts it has no particular advantage, and in warm regions clothed with vegetation, but with a relatively dry atmosphere, it is probably disadvantageous."

While Parker's examples are Old World forms and my experience has been in America, I do find myself in agreement with his principal premise, namely that, in the desert, sand-dwelling forms are predominantly light in color, while rock-frequenting species are relatively darker and some are quite dark. But with his conclusion that this difference results from the beneficial effects of cooling by conduction in the one case and by radiation in the other I do not concur.

First as to the premises: It is true that in our southwestern deserts, as in the Transjordan Desert to which Parker refers, sand-dwelling diurnal lizards are usually light in color, outstanding examples being *Dipso-saurus dorsalis dorsalis, Uma notata, Callisaurus ventralis,* and *Phrynosoma m'callii.* There are others, not exclusively desert dwellers, which are lighter in the desert area than elsewhere in their ranges, such as *Crotaphytus wislizenii* and *Uta stansburiana.* In the category of rock-dwellers we have the following diurnal lizards: *Crotaphytus collaris, Sauromalus obesus, Uta mearnsi, Uta microscutata, Uta ornata symmetrica,* and *Sceloporus magister.*[*] Making allowances for territorial differences, and the power of individual color change which many lizards possess, it can be said that these forms, on the average, are definitely darker than the sand-dwellers, and some are very dark.

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[*] In some areas S. *magister* frequents trees and shrubs.

The fact that desert temperatures, particularly the ground temperatures, whether of sand or rocks, reach higher values than any poikilothermous animal can endure is too well known to require discussion; it has been the subject of many excellent papers and field notes during the past several years (e. g. Mosauer, 1936). Therefore we do know that desert forms must either curtail their activities to times when the temperatures of sand and air are below the lethal temperature, that is, they must become crepuscular or nocturnal; or they must, as suggested by Parker, make forays and retreat into the sandy subsurface or rock crevices before radiation or conduction has caused a fatal rise in body temperature.

We may eliminate the snakes from discussion with respect to this choice. Their relatively slow movements and their intimate contact with the ground, whereby they suffer from surface conduction, so operate to their disadvantage that the foray type of life is quite impossible to them. Of our southwestern desert snakes, only the red racer, *Coluber flagellum frenatum*, would be speedy enough to adopt the foray type of prey capture with any degree of success; and even this snake, while primarily diurnal elsewhere in its range, becomes largely crepuscular in mid-summer on the desert. *Salvadora* does likewise. *Pituophis* and *Lampropeltis* become quite nocturnal; and other more specialized desert forms such as *Arizona*, *Sonora*, *Chilomeniscus*, *Phyllorhynchus*, and *Crotalus cerastes* are essentially nocturnal at all times.

The lizards as a group have the advantage over the snakes that they can (and do) raise their bodies above the ground, thus avoiding the worst effects of conduction. This is especially true of those which run on sand, but perch on small stones, as, for example, *Dipso-saurus* and *Callisaurus*, for they are frequently seen standing with bodies elevated on stiffened legs. Not all lizards take advantage of this method of avoiding conduction; one of the darkest of the persistent rock dwellers, *Sauromalus obesus*, is too heavy-bodied to do this. He hugs his rock until it is too hot and then seeks refuge in some convenient crevice.

Another advantage possessed by the lizards over the snakes is their higher speed, which permits them to venture onto dangerous ground with the certainty of getting back into the shade before a fatal temperature is reached. Also the air movement involved in relative motion aids the dissipation of absorbed radiant energy into the atmosphere by convection. The aid to heat transfer involved in disturbing what would otherwise be a static air-film is important, for, as is well known in machine design, windage greatly expedites convection. Thus forays are possible to lizards; the question is whether they adopt this method of life to an important degree at times when the temperature is lethal.

I think it clear that high absorptivity can be construed as a benefit to a dark-colored desert-dweller only if he adopts the foray method of existence. For it must be apparent, that, as long as he is in the sun and subjected to direct solar radiation, his dark color will accentuate heat absorption and be to his disadvantage. It is only when he has retired to a crevice after a foray, that his temperature is above that of his surroundings, and a high absorptivity (and therefore high emissivity) would be beneficial. Once his temperature has reached the level at which it is practically that of his surroundings, being higher only by reason of the slight amount of heat generated by his metabolic processes, there will no longer be a heat gradient, so that his color is no longer important. He cannot absorb heat by conduction and dispense it by radiation, unless he is resting on a hotter rock than the others which comprise the walls and ceiling of his crevice or cave; for without a positive gradient to surrounding objects, there will be no net radiation. And if such a condition does exist he will merely seek the cooler rock. In the absence of a temperature gradient color is unimportant; and certainly the metabolic processes of a quiescent lizard will not create such a gradient. Hence I can conceive the dark color of the crevice-seeking form as of radiation-protective value only immediately after a foray during which a lizard has become over-heated. And it may be pointed out against this theory, that while the dark lizard will be benefited by cooling faster after his foray, he will also be penalized by heating faster during his venture into the sun, which quite counterbalances the supposed advantage.

But there are other more serious objections to ascribing these color differences between the rock- and sand-dwellers to radiation absorptivity. First the modes of life of the two groups, with respect to their methods of protecting themselves from excessive radiation, are not as different as would appear from a mere consideration of the character of the ground surfaces. For the sand-dwellers take refuge very largely in ground holes; and here it would be just as strongly to their advantage to cool rapidly by radiation after a foray as it would be for the rock-dwellers in their crevices. After all a desert is not a uniform waste of sand. In such a place life would indeed be scant, since every animal and his prey could take refuge only by swimming below the sand-surface. Deserts are more diversified; they vary from masses of barren rock to drifting dunes of sand, through various stages of scattered boulders, lava fields, small stones, aeolian detritus, alluvial fans, dry lakes, and silt; but throughout there is more or less vegetation; often sparse, it is true, and protected by thorns and spines, but still the fundamental basis of the animal life. Even in the great sand-dune areas of southern California which lie in a broad band west of the Colorado River (Hollywood's Sahara) there are scattered, stable patches where a few plants battle for existence. Where there are plants there is some shade of which the lizards take advantage—but what is more important there will usually be found the semipermanent burrows of various desert mammals. These, for the protection of their owners, have been driven to a depth where the temperature is livable; and in these the sand-dwelling reptiles find refuge, just as the rock-dwellers seek deep crevices. In these holes the benefit of rapid radiation after forays would be as effective for the sand-dwellers as for the rock-dwellers in their crevices; thermally their situations are similar. I do not say that the sand-dwellers never protect themselves by swimming beneath the surface, for they do, if there is no other retreat available, but they rarely find themselves in such a situation.* Certainly *Dipso-saurus* and *Callisaurus* will seek holes in preference to sand; and even our most specialized lacertilian sand-swimmer, *Uma notata,* will not scorn a hole if one be at hand. Under the theory suggested by Parker all of these forms with the single exception of *Uma* should be dark. But they are notably light.

If the rock-dwellers primarily depended on forays they should be at least as speedy as the sand-dwellers. Such is not the case. *Uma,* a lizard whose activities are almost entirely restricted to loose sand, is very fast; and *Callisaurus ventralis,* another form preferring sand, silt, or small scattered pebbles, is so speedy that it cannot be followed with the eye when traveling across the line of sight. It is, I think, the fastest of the smaller animals of the desert. There is no diurnal denizen of the sandy flats that can be called slow. On the other hand *Sauromalus obesus* is both the darkest and most conspicuous of the confirmed rock-dwellers. Yet it is slow moving, and would be further handicapped, were it restricted to a foray method of existence, by being herbivorous, with its food, of which relatively large quantities are required, sparse and slowly ingested.

From a considerable experience in hunting reptiles in desert areas I am led to believe that the foray method of prey capture is not indulged in extensively at those times of the day when the temperature of the ground surface in the sun is such as would cause the death of any reptile which risked the open for more than a few moments. For, before the ground temperature has reached the extreme danger point it is already decidedly uncomfortable, and, as far as the carnivorous reptiles are concerned, their prey is subject to somewhat the same limitations as the predators, although the mammals are better able to withstand the extreme temperature than the reptiles.

Of course there is always a time of transition during which lizards may make short forays and retreat to the shade of a bush or a rock crevice. But, generally speaking, the fact remains that during mid-day all life seems vanished in the desert. The experienced hunter knows this and plans his hunting for the mornings and his traveling between stations for the afternoons. The time of day when lizards seek their retreats depends on a number of factors, such as the time of year, the air temperature, the surface temperature of the ground, subsurface temperatures, and, no doubt, the humidity and wind velocity, so that one cannot regulate his hunts exactly by the clock. But in general it can be said that there is little use in hunting lizards after ten o'clock in the morning, once the spring has advanced to the point where the surface temperature at midday is high. An occasional lizard may be found in the shade of a bush, or a rare individual may even be seen flashing across the sand; but reptile hunting, either as a scientific pursuit or a sport, is a waste of time. This is true both in rocky and sandy areas. In the late afternoon there may be some renewal of activity, but it seems never to equal that of the morning.

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* *Chilomeniscus cinctus* and *Leptotyphlops humilis cahuilae* are essentially sand-swimmers in some areas, as indicated by their tracks, but they are completely nocturnal. In the daytime they are at a depth sufficient for protection against the surface heat.

The difference noted in the extent of reptile life in evidence on the desert within an hour may be quite surprising. I recall on one occasion an area in Mohave County, Arizona, some few miles east of Topock, where, on May 30th at about 9:30 in the morning, the country seemed literally to swarm with lizards. It was a district of mixed sand and small stones, with a few larger rock outcrops. Each small stone seemed to serve as a lizard perch, particularly for *Dipso-saurus dorsalis dorsalis, Crotaphytus collaris baileyi, Callisaurus ventralis ventralis, Phrynosoma platyrhinos platyrhinos,* and *Uta stansburiana stejnegeri. Cnemidophorus tessellatus tessellatus* and *Crotaphytus wislizenii* were cruising through the bushes, *Sauromalus obesus* and *Uta ornata symmetrica* were on the larger boulders, and *Sceloporus magister magister* was active in the mesquite thickets. Within an hour or so all these creatures had disappeared—as far as animals were concerned the desert appeared a shimmering, barren waste.

No, I think that the general difference in coloration between the sand-dwellers and the rock-dwellers must be sought elsewhere than in different methods of cooling after forays into a dangerously heated area, for they do not live by such forays; and even if they did, their retreats are so similar thermally, that they should result in similar color schemes. It seems to me the often-scorned theory of protective coloration gives an answer which better fits the facts, or at least many of them. For the sand, silt, and detritus are usually light in color—white to gray or tan; while the rocks are dark—from dark-gray or dark-red to the black of many desert lavas. And, furthermore, even the lighter boulders are seamed with irregular dark fissures and crevices; and a lizard clinging to a rock often resembles one of these, as anyone who has hunted *Uta ornata* or *U. mearnsi* will testify. Also a dark lizard within a shallow crack is less visible than a light one.

An example may be cited of how certain facts of coloration seem to fit the theory of protective coloration somewhat better than the theory of protective radiation reflectivity. We have in the southwest a very widespread little lizard, *Uta stansburiana.* It occurs from the seashore far out into the desert in every life zone from Lower Sonoran to Transition, amongst sand, rocks, chaparral, or trees. Now these lizards seem to have some power of individual color change; but, even allowing for this, they are lighter in the desert than in the coastal foothills. This might be explained either on a basis of protective coloration or advantageous albedo. At various points along the southern California coast there are found barrier beaches inhabited by these *Utas.* These beaches are cooled by the sea-breeze and spindrift; furthermore the summer mornings are habitually overcast. As a result the average temperature must be considerably below the optimum for this or any other lizard. From the standpoint of the absorption of desirable radiation these lizards should be dark in color. But the sands are light and the beach lizards are the lightest of their species, lighter even than the desert individuals.

Mr. Parker, although admitting that his newly described black lizard is found in a black lava desert, argues against the theory of protective coloration because, when certain areas were painted white in connection with aircraft guides, the lizards seemed to select the white areas (where they were very conspicuous) as frequently as the black. In refutation the following theories may be advanced:

(1) The white areas may have been selected by the lizards because they were cooler, this temperature difference being mentioned by Parker.

(2) The relative abundance may have been more fancied than real, since the white surface would make the individuals thereon more conspicuous.

(3) Protective coloration may have exerted a selective effect through the ages, even though the individuals of a single generation may not know enough to avoid an unfavorable background created outside of their normal experience.

It should be understood that I do not take the position that radiation has no effect on the colors of reptiles or that protective coloration explains everything. On the contrary I agree that, in circumstances where average temperatures are below the optimum for poikilothermous animals, diurnal species are likely to be dark, and where the contrary is true they are usually light. This probably accounts in part for the evident general lightness of our Lower Sonoran reptilian fauna as compared to the same or corresponding forms when resident in the Upper Sonoran or Transition Zones. There are numerous examples of this trend amongst both the lizards and snakes, some of which are mentioned later. But it should be observed that in these cases protective coloration and beneficial albedo are working toward a common end; for the Upper Sonoran and Transition backgrounds, both of soil and vegetation, are darker than on the desert. The question arises as to which effect takes precedence when the two would tend to produce divergent results. I think the cases of the seashore utas and the dark, desert rock-dwellers indicates that protective coloration is likely to exert the controlling influence. I am of the opinion that the general darkness of rock-dwellers may be somewhat to their disadvantage thermally, but this they can compensate for by modifying their periods of activity. But if they have little or no power of individual color change, then it is of first importance that their colors be in fair accord with their surroundings. Indeed it is sometimes surprising to note the degree to which color matching is evident in desert reptiles. We note, for example, the way in which *Uma notata* matches the hue of the sand on which it runs, being cream on the cream-colored sands west of Yuma and grayish-white on the lighter sands of the Mohave. The sidewinder, *Crotalus cerastes*, follows a similar trend.

Of course I realize that there is over simplification in this discussion—the kind from which the theory of protective coloration has long suffered. When it was brought forth to explain every variation of hue, shade, and pattern it was easy to point out exceptions, or instances in which color seemed to be to its possessor's disadvantage, so that it fell into disrepute in some schools of thought. Actual tests on the survival value of protective coloration (Sumner, 1934, 1935a, 1935b; Isely, 1938), using prey and predators, are tending to restore its accepted importance.

Color is not a simple problem, since we cannot see through the eyes of predators, and hence cannot be sure of the relative protective values of hues and patterns. Much experimental work remains to be done before facts can supplant suppositions. And protection against destructive or surplus radiation (or the beneficial effect of increased absorptivity, where radiation is inadequate) is even more complicated and untested. For of the solar radiation reaching the earth, that which affects the eye as light comprises only a narrow band of frequencies between two other bands toward the infrared and the ultraviolet; and until the absorptivity and reflectivity of reptile bodies are actually tested under various wave lengths of radiation invisible to our eyes, we can only make the assumption (probably only partly valid) that the total radiation absorptivity is proportional to the visible depth of color.

Assuming that we were able to shift our eye susceptibilities to various wave-length bands, as can be done by instrumental detectors, a certain creature might appear white to us when our eyes were adjusted to be responsive to ultraviolet, but would be black when we had readjusted them for use in the infrared (long-wave, low-temperature radiation). This way of stating the case is merely presented to make clear the fact that when we are talking of colors and the albedo of a creature as his skin affects our eyes, we are doing little more than guessing at his real color, shade, or albedo, throughout the whole range of solar wave lengths which may affect him through thermal or chemical action. For, in this broader sense, but using our well understood color-perceptions in the place of the less frequent terms of absorptivity, reflectivity, and transmittancy, it is apparent that this single creature may be, at one and the same time, both black and white. Actually he probably varies through several shades of light and dark gray. To some frequencies he is no doubt translucent. Thus these animals may possess, in their surfaces, selective absorptivities, that is, invisible colors, at various wave lengths beyond our vision, and of these we can know nothing until adequate tests are made.

Then there is the further complication that surface roughness increases air film conduction, both by turbulence and increased area. There is the protection of vital organs by surface projections and by internal colors, as, for instance, the black film present as a body-cavity lining in so many desert reptiles (e. g. *Uma, Callisaurus, Sauromalus, Crotaphytus, Phrynosoma*) but absent in others (*Cnemidophorus, Coleonyx*). While it is usually assumed that light-colored reptiles are good reflectors of radiation and poor transmitters, these internal color films suggest that this is not true at all solar wave lengths, particularly those of the actinic rays in the ultraviolet.

By reason of these little known conditions, that is, color perceptions of predators, and the response of reptile skins and bodies to the complete gamut of incident radiation, it must be admitted that a discussion of the relative values of protective coloration and protective reflectivity, and particularly what happens when the two tend toward opposing effects, must indeed be replete with speculation. Nevertheless, on the assumptions that predators have somewhat the same visual range, at least with respect to shade, if not hue, that we possess; and that skin absorptivity and reflectivity are somewhat proportional to the response of these skins to visible light, we may draw certain tentative conclusions from our studies of desert reptiles.

I first wish to make further observations concerning the differences between coastal and desert forms in the southwest, and, between rock- and sand-dwellers on the desert.

Of the first difference there can be no question; it is evident in almost every species which is to be found in both areas, for the coastal forms are dark (except in such specialized cases as the *Uta* previously mentioned), while the desert individuals are relatively light. Examples are, amongst the snakes: *Lichanura roseofusca roseofusca, Coluber flagellum frenatum, Salvadora grahamiae* (coastal subspecies, *S. g. virgultea*—desert subspecies, *S. g. hexalepis*), *Arizona elegans occidentalis, Trimorphodon vandenburghi,* and *Crotalus ruber;* and amongst the lizards *Crotaphytus wislizenii, Uta stansburiana* (coastal subspecies *U. s. hesperis*—desert subspecies, *U. s. stejnegeri*), and *Cnemidophorus tessellatus* (coastal subspecies, *C. t. stejnegeri*—desert subspecies, *C. t. tessellatus*). *Crotalus viridis oreganus* is a particularly interesting example, since the mountain individuals, both in southern California and Arizona, are quite black, while those from the lowlands are much lighter. This species barely ventures into the edge of our true deserts; but in the southern end of the San Joaquin Valley, its nearest ecological approach to a desert, the snakes are so light that they are sometimes confused with sidewinders (*Crotalus cerastes*). Other rattlers, particularly *Crotalus cinereous* and *C. scutulatus,* show the same ecological variations.*

Before leaving this matter of color tendencies from Transition through Upper to Lower Sonoran Life Zones, it may be mentioned that our dark cismontane reptiles show a development somewhat at variance with one of Parker's suggested beneficial tendencies wherein he says: ". . . . in warm regions clothed with vegetation, but with a relatively dry atmosphere it (melanism) is probably disadvantageous." Our chaparral belt in the coastal foothills is just such a region, for it is thickly clothed with vegetation, and hot and dry in summer it certainly is. Yet the reptiles of that area are notably dark; wherever a species is found both here and in the desert, the chaparral dweller will be considerably the darker.

But I think the dark colors of the reptiles in the chaparral belt are definitely beneficial, whether from the standpoint of protective coloration (as the foliage, rocks, and most of the soils are dark), or albedo, since these reptiles are all most active during the spring mating season and when they are most in need of food, which is immediately after hibernation. At this time radiation averages below, rather than above, the optimum. This is not the case on the desert, where the optimum temperatures for the diurnal reptiles are attained earlier in the season; and here also the soils and sands are lighter.

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* A more complete discussion of zonal color variations will be found in Klauber, 1931, pp. 46-53.

As to the differences ascribed to sand-dwellers, as opposed to rock-dwellers, in the desert, I know of no place where they can be compared to better advantage than on the road westward from Death Valley to Owens Valley. Here one crosses successively three mountain ranges, the Panamint, Argus, and Inyo Mountains. In the valleys between are dry lakes and sandy washes and here the typical lizards are *Callisaurus ventralis gabbii* and *Dipso-saurus dorsalis dorsalis.* Climbing up the alluvial fans *Crotaphytus collaris baileyi* and *Phrynosoma platyrhinos platyrhinos* become more in evidence, usually perched on the scattered boulders. Toward the mountain crests the country becomes increasingly rough, with great masses of rocks, and here *Sceloporus magister magister* is the commonest lizard, with a few *Sauromalus obesus. Uta stansburiana stejnegeri* and *Cnemidophorus tessellatus tessellatus* are everywhere, from the lowest to the highest points; but generally one gets the impression of a definite stratification, with light lizards at the bottom where sand predominates and dark (especially S. *m. magister*) at the top amongst the rocks.

It should be understood that while I speak of the sand-dwelling diurnal lizards of our desert as being generally light in color, this does not mean that they are white, although they often give such an impression. Dorsally they run to light grays, tans, or browns; ventrally they are usually white. Reptiles which are present in both the Upper and Lower Sonoran Life Zone in the southwest usually develop the lighter tone, which is characteristic of the desert-dwellers as compared with those of the chaparral, in two ways; first by a lightening of the pigment in the ground color and pattern (sometimes in only one of these two); secondly, by increasing the unpigmented area on the sides. As an example of the latter scheme it may be observed that *Arizona elegans occidentalis* on the coast of southern California is usually pigmented to the first or second row of dorsal scales above the ventrals, whereas, in the desert, four or five rows are generally unpigmented. A difference of both types is also noted in *Crotalus ruber,* wherein the dark red-browns of the coastal specimens are replaced by lighter reds; the light diamond borders are more in evidence and are almost white. Also the ventral color is higher on the sides.

It is of interest to note that desert night snakes are light colored, whether they are desert forms exclusively (e. g. *Crotalus cerastes, Sonora occipitalis, Phyllorhynchus decurtatus perkinsi*), or the congeners of darker coastal forms (e. g. *Arizona elegans occidentalis, Leptotyphlops humilis cahuilae, Tantilla eiseni*). Here again we may explain the color as being beneficial both from the standpoint of protective coloration (assuming that night predators hunt by the—to us—dim visible radiation), and radiation absorptivity (or, in this instance, emissivity). For these snakes, likewise, are most active in the spring, which is the mating season and that of hunger after hibernation. At this season ground temperatures are at an optimum early in the evening; in general, during this period of maximum activity, there is probably a greater duration of time when the temperature is below than above the optimum. A snake, acquiring beneficial heat from the ground surface by conduction, will hold such heat to better advantage if his emissivity is reduced by a light color.

We have no diurnal desert snakes to compare with respect to habitat (that is, rock- vs. sand-dwellers) since all become at least partially crepuscular in summer; but we do have nocturnal snakes, some of which are usually rock-dwellers, while others prefer sandy or alluvial areas. Omitting those which are diurnal or crepuscular in the spring and become nocturnal only in the hottest parts of the summer, we have, as rock-dwellers, *Trimorphodon vandenburghi* and *Hypsiglena ochrorhynchus;* while those of the flats are *Arizona elegans occidentalis*, *Sonora occipitalis*, *Phyllorhynchus decurtatus perkinsi*, and *Crotalus cerastes*. Here again (as in the diurnal lizards) the rock-dwelling forms are the darker.

Of the lizards which are almost entirely restricted to night activities (many desert diurnal lizards are occasionally found out at night), *Xantusia henshawi* and *Phyllodactylus tuberculosus* (rock-dwellers) are dark, while *Coleonyx variegatus*, the only regularly nocturnal lizard-dweller of the flats is light. *Xantusia vigilis*, while occasionally found in rocks, cannot be considered a rock-dweller. Its predilection to yuccas may explain its dark color, for the gray, dead yucca stems which it frequents are the color of rocks, and the spiked leaves stripe the stems with dark shadows.

While it is probable that night predators may be proportionately less dependent on sight than those whose activities are restricted to the day, we are led to assume from the patterns of the night snakes that sight plays a part. For not only are there these color differences which seem intended to match the surroundings, but we find the same blotch patterns which characterize the slow moving diurnal forms. These blotches break up form in a static object, and also cause it to be suddenly lost to sight by the disappearance of the spots when it moves, so that the blotches are beneficial, both when the animal is still and when it moves, especially at the beginning of that motion.* It would be difficult to explain the astonishing parallelism between the patterns and colors of *Sonora semiannulata*, *Sonora occipitalis*, *Chilomeniscus cinctus*, and, to a lesser extent, *Rhinocheilus lecontei*, on any basis of chance. One can hardly escape the conclusion that these colors are effective at night notwithstanding the faint illumination.

The barred underside of the tail of *Callisaurus* is an example of the effect on vision of a sudden change in aspect; it is even more perfect than the blotches of a snake. When this lizard stops the tail is curled over the back and is usually swayed slowly from side to side so that the alternating black and white bars of the undersurface are very conspicuous. The eye is arrested both by the color and motion. Then as the lizard darts away at high speed, the eye remains static; it fails to follow the neutral gray flash, which so well matches the surroundings.

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* For a discussion of the correlation of pattern with speed see Klauber, 1931, p. 43.

How may the white on the sides and bellies of the diurnal desert forms be accounted for? This again may be presumed beneficial from the standpoint of both radiation-absorption and visual color. For the white of the sides reflects a maximum of the incident radiation, which includes the reflection of the incident visible color of the ground. That is, if the ground be gray, this color is reflected from the sides, if it be cream then cream will be reflected. This effect is not always appreciated, since the white suffers somewhat by comparison with the deeper tone of the adjacent primary radiating surface. However the existence of this reflection can be tested by holding a white paper at a sharp angle with a red and a green book which are in the sunlight. White surfaces tend to match the colors of the nearby areas from which they receive reflected light; and also by reflection they tend to lighten and soften shadows on the dark side. So much for the color; as to the desirability of a high albedo in areas where the radiation is usually above the optimum, this has already been discussed. Even the undersurface is subject to some radiation.

A black surface, to the extent that it approaches pure black-body emissivity, has but one character with respect to radiation, this being absorption. But a white surface may be either reflecting or transmitting; most often it is a mixture of the two. If it is predominantly transmitting in the visible range of the spectrum it will take on the character of translucence. Such translucence is noted in the worm snake *Leptotyphlops humilis cahuilae* and in the gecko *Coleonyx variegatus*, in which the internal organs are dimly visible through the skin. It is not so evident in any diurnal reptile. We usually assume that dead white is fully reflecting but such is probably far from the case. The present tendency to paint desert helmets with aluminum paint, sacrificing apparent color to reflectivity, probably results from finding that some rays which the aluminum turns back were penetrating the dead white of the old helmets.

Only tests will demonstrate the exact character of the skins of reptiles, with respect to the absorption, reflection, and transmission of radiant energy; and such tests must be made across the full solar spectrum, rather than being restricted to the visible band. From the standpoint of color protection only, the visual-acuity range of the predators is important; but such is not the case from the standpoint of the thermal and chemical effects of the incident radiation.

The fact that some rays tend to penetrate ordinary reptile surfaces, particularly when these are light in color, may be assumed from the presence in many reptiles of the black peritoneum previously mentioned, particularly in the desert diurnal forms. Black membranes are conspicuous in such forms as *Uma, Callisaurus, Sceloporus magister, Dipso-saurus, Crotaphytus collaris baileyi, Crotaphytus wislizenii, Sauromalus obesus. Phrynosoma m'callii, Phrynosoma platyrhinos*, and *Phrynosoma blainvillii.* They are absent in

Coleonyx variegatus, Eumeces obsoletus, Cnemidophorus tessellatus, Phyllorhynchus decurtatus, and *Sonora occipitalis.* They are absent in most of our southwestern desert snakes, being somewhat in evidence posteriorly in the two forms which have the largest proportion of daylight activity: *Coluber flagellum frenatum* and *Salvadora grahamiae hexalepis.* An interesting situation exists in *Xantusia,* for the black membrane is present in *X. vigilis* and *X. arizonae,* but is absent in *X. henshawi.*

The color of an internal film bathed on each side with moisture can only be explained on the theory of its effect on external incident radiation. It could hardly be important from the standpoint of conserving internal heat, because of the low metabolic temperature-differential of poikilothermous animals, and the all-important part that conduction would play with respect to such heat. Rather it seems to be a second line of defense against the penetration of injurious rays, for an internal dark film cannot reduce the total thermal flux. Much of the incident radiation is reflected at the light surface of the animal; some is absorbed and transformed into heat; that which gets through the skin and muscles (particularly the actinic rays in the ultraviolet) is absorbed and transformed into heat before it can have deleterious chemical effects on the internal organs. That some ultraviolet radiation is necessary to these animals is borne out by the beneficial use of artificial ultraviolet radiation on captive specimens in zoos.

It is interesting to note the belly wall of *Dipso-saurus.* Here we have a relatively thin membrane, shiny white on one side and dead black on the other; no more efficient barrier to radiation could be devised on the theory of "reflect what you can, stop and transform what you can't." Even on the undersurface of a reptile, heat transference is not solely a matter of conduction and convection, for radiation plays some part.

We are all familiar with the power of some lizards to change color under various conditions of excitement, temperature, etc. The color change in *Uta graciosa,* from almost black to cream, is an example amongst our southwestern lizards. Even certain snakes, such as *Crotalus cerastes* and *Crotalus viridis oreganus,* possess the power in some degree. Since the present discussion has to do with the more permanent colors, I shall only touch on this power of individual color change to the extent of observing that it is conceivable that changes in absorptivity and reflectivity may be produced quite aside from, or out of proportion to, observed visible color changes. In other words a creature might change its albedo without conspicuously changing its apparent color, that is, the color within the visible band. Hence it may be possible to affect radiation absorption without a proportional change in color from the standpoint of protective coloration.

To whatever extent lizards and other reptiles may have the power of individual color change (meaning by this a change of tint or shade, rather than hue, and referring to color in the broader sense, not limited to the visible spectrum), they will be benefited by light colors when it is advantageous to inhibit radiation transfer, and by dark colors when it is beneficial to promote transfer, regardless of the direction of the temperature gradient. Thus light colors would be preferred under conditions of (1) high incident radiation and a super-optimum body temperature; or, (2) low incident radiation and a temperature below the optimum, but where the gradient is outward. Conversely, dark colors would be desirable under (3) conditions of a high incident radiation, but sub-optimum body temperature; or, (4) a low incident radiation with a temperature above the optimum. In the life of desert reptiles these situations might arise under such conditions as the following: (1) In sunlight when the body temperature of the reptile is already at or above the optimum; (2) in shade when the air temperature is below the optimum, but the ground is still warm, the heat from which, secured by conduction or convection, or heat derived from animal metabolism, it would be profitable to conserve; (3) in sunlight at times when the air and ground temperatures are below the optimum and it is desirable to absorb a maximum amount of solar radiation; and (4) in shade when taking heat in excess from the ground by conduction, or when overheated from recent exertion.

Obviously conditions (1) and (3) are far more frequent and important than (2) and (4), since the diurnal lizards of the desert spend their most essential food-getting hours in the sun. An adherence to this schedule would require or induce a light color at super-optimum temperatures and a dark color at temperatures below the optimum. This is in accordance with the findings of Dr. Sarah R. Atsatt, in her important researches on a number of our southwestern lizards.*

In any case, however, the fundamental average differences between the dark coastal forms and their lighter desert analogues, or between the darker rock-dwellers of the desert and their lighter sand-inhabiting neighbors, should not be ascribed to exhibitions of individual color change. This is shown, first by the fact that the same differences are exhibited by the snakes, which have little or no power of color change; in fact, there are those who say that no snake has any such power, although I am certain that it is evident to a slight degree in some species of *Crotalus*. Secondly, with respect to the rock- and sand-dwellers of the desert, it must be remembered that the general comparison of their relative darkness and lightness, as groups, is made when they are at substantially the same temperatures. There is no doubt that an average difference does exist at any temperature.

It is far from my purpose to say that every variation of pattern, hue, shade, and tint in desert or other reptiles can be explained by either protective coloration or beneficial adaptation to incident radiation. Such is not the case. There are many things which these two principles will not explain, at least as far as the facts are known.

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*The publication detailing Dr. Atsatt's experiments arrived while the present paper was in page proof. It is entitled "Color changes as controlled by temperature and light in the lizards of the desert regions of southern California," Pubs. U. C. L. A. in Biol. Sci., Vol. 1. No. 11, pp. 237-276, 1939. It makes extensive additions to our knowledge of color changes with respect to the number of species having this power, the character and extent of the changes, and the external causal conditions.

There are species which appear to violate rules which seem to be to their best interests. For instance, I cannot explain the black throat of *Cnemidophorus tessellatus* (*melanostethus*) in the Tucson area, while the same species in the Colorado desert has a light throat and under body. The conditions with respect to both protective coloration and high reflectivity appear to be similar in the two areas. But if we can successfully account for certain general tendencies in the majority of these reptiles upon a basis of beneficial selection, by applying theories of protective coloration and protective reflectivity against radiation, we have at least based our suppositions upon reasonable and logical interpretations of the facts.

SUMMARY AND CONCLUSIONS

Protective coloration seems to have an important bearing on the colors and color variations of the reptiles of the southwest. In some situations protective coloration and protective reflectivity work to the same end; where the two would tend to produce opposite results, protective coloration seems to be controlling. These conclusions are speculative, since we lack adequate data on the visual acuity of predators, and on the response of reptile surfaces to incident solar radiation of wave lengths which do not affect human vision.

REFERENCES

Hibben, S. G. and Blackburn, P. W.
1938. Sterilization by ultraviolet radiation. Electrical Engineering, Vol. 57, No. 11, pp. 455-459.

Isely, F. B.
1938. Survival value of acridian protective coloration. Ecology, Vol. 19, pp. 370-389.

King, W. J.
1932. The basic laws and data of heat transmission. Mechanical Engineering, Vol. 54, pp. 190-194, 275-279+296, 347-353, 410-414+426, 492-497, 560-565.
1936. Heat transmission. Kent's Mechanical Engineer's Handbook, Sec. 3, pp. 26-36.

Klauber, L. M.
1931. A statistical survey of the snakes of the southern border of California. Bull. Zool. Soc. S. D., No. 8, pp. 1-93.

Mosauer, Walter
1936. The toleration of solar heat in desert reptiles. Ecology, Vol. 17, pp. 56-66.

Parker, H. W.
1935. A new melanistic lizard from Transjordania, and some speculations concerning melanism. Proc. Zool. Soc. London, 1935, pp. 138-142, plate 1.

Steinmetz, Chas. P.
1909. Radiation, light and illumination. pp. XII+305.

Sumner, F. B.
1934. Does "protective coloration" protect? Results of some experiments with fishes and birds. Proc. Nat. Acad. Sci., Vol. 20, pp. 559-564.

1935a. Evidence for the protective value of changeable coloration in fishes. Am. Nat., Vol. 69, pp. 245-266.

1935b. Studies of protective color change. III. Experiments with fishes both as predators and prey. Proc. Nat. Acad. Sci., Vol. 21, pp. 345-353.

PART III.

NOTES ON SOME LIZARDS OF THE SOUTHWESTERN UNITED STATES

INTRODUCTION

During the past fifteen years I have accumulated a number of miscellaneous notes on the lizards of the southwestern corner of the United States, particularly those of the Colorado and Mohave deserts. It now appears opportune to present them as a third section of these studies of our southwestern reptiles. I shall first touch on some general observations with respect to this suborder, followed by the more detailed notes segregated by species.

HUNTING METHODS

All lizards are so much more common than almost any snake that the taking of adequate series is usually only dependent on a study of their habits and habitats, and the perfection of methods of capture. Of course every species has limits to its range, either territorial or topographical, and certainly as these limits are approached the individuals become scarce. But if one be given his choice as to the area wherein captures are to be made so that he is not restricted to the fringe of a range; if the collector is allowed to choose his hunting season; and if he be familiar with the habits of his quarry and the special schemes which have been devised for their capture—then I know of none which cannot be taken in quite adequate numbers. Probably the rarest in San Diego County are *Eumeces gilberti rubricaudatus* on the coast, and *Phrynosoma m'callii* on the desert. I exclude *Cnemidophorus hyperythrus* and *Phyllodactylus tuberculosus* since both of these, in the territory under discussion, are range-edge forms. *Crotaphytus wislizenii,* while a widespread lizard, and by no means rare, appears to be nowhere concentrated in large numbers—that is, concentrated as are *Xantusia vigilis* in the yucca groves of the Mohave; *Crotaphytus collaris baileyi* on the scattered boulders south of Ashfork, Arizona; *Sauromalus obesus* at Goldroad; or *Phrynosoma platyrhinos platyrhinos* on the slopes of the Panamints. The collection of a lizard of this type more nearly resembles snake collecting—to a certain extent it is a matter of luck and persistence.

To collect most of our southwestern lizards, whether they frequent rocky areas or sandy flats, or both, is merely a case of hunting with a .22 rifle and dust-shot shells at the proper time of day and in a suitable area. A sharp eye for movement, and a slow but steady approach to get within range, are the principal requisites. Rocks should be flipped over when the quarry is seen to take refuge under them; this is the easiest way to catch *Crotaphytus collaris baileyi.* Occasionally a specimen must be dug out of a hole. Where shooting is not permitted, a thread noose on a willow switch, or on a .22 ramrod, does very well.

I have stated elsewhere that the best time for hunting diurnal lizards in the southwest is the morning, the hour depending on the season and the altitude. In the early spring the lizards appear in their greatest profusion from about 10:00 A.M. until noon. Later in the summer they are out much earlier—in midsummer just after sunup. As the heat grows too intense they retire, first into the shade of bushes; then into ground holes or under rocks. There is a resumption of activity in the late afternoon, but not equalling that of the morning.

Some of the nocturnal and secretive forms require special techniques for their capture; these will be discussed under the individual species.

ISLAND EXPERIENCES ON LAKE MEAD

One of the most interesting lizard collecting experiences I have had was on Lake Mead (the lake impounded by Boulder, formerly Hoover, Dam) at a time when the water was rising and engulfing various islands which had formerly been hilltops. This scheme of collecting had occurred to other herpetologists, notably A. E. Borell, who tried it in May, 1935, and R. B. Cowles and C. M. Bogert, who collected on several islands in July and August of the same year and have since outlined their experiences.*

When visiting the dam in the spring of 1935, after the impounding of water had begun, I heard stories of the great number of reptiles concentrated on the hilltops just before inundation; however the opportunity to secure some of this doomed material did not occur until the summer of 1936, a year after Bogert had tried it out. Then in company with Messrs. F. H. Lane, John Dern, and my son Philip, I visited 19 temporary islands, 4 on the afternoon of June 15 and the rest next morning. On the first day the water was quite rough; it is doubtful whether reptiles could have swum any great distance under such conditions. However next morning it was quite smooth.

We were told by the boatman, both at this time, and on two previous trips when I had not visited islands, that snakes (including rattlers) were often seen swimming in the lake. Bogert was given the same information the year before. This probably accounts for the lack of snakes on the islands, for we secured only one.

At the time of our hunt the water stage had just passed the 1,000 ft. contour. Thus the water was about 350 feet deep at the site of the former boat landing at the foot of Hemenway Wash, where we had hunted several years before. Without a close study of a contour map it is impossible to tell how large our several islands were at the time the rising water first separated them from the shore. No doubt they had originally varied from a few acres to many hundreds, the latter being the case with those which, when they were finally engulfed, were distant from any shore. The water level had risen at an average rate of 1.3 ft. per day during the ten days prior to our visit and rose 1.1 ft. on June 14. But nowhere was the lizard concentration what might have been expected on the theory that an entire population of a hill would be crowded onto the last remaining peak. It was evident that many had swum away, had been drowned, or had been picked off by predators before the islands had been pinched down to the rocky islets, or tiny sand bars, on which we collected.

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* The Herpetology of the Boulder Dam Region. Herpetologica, Vol. 1, No. 2, pp. 33-42, 1936.

The results may be summarized as follows: Of the 19 islands, 6 produced no reptiles. Two of these were relatively large rocky islands about 200 ft. in circumference and up to 40 ft. out of the water. Obviously there may have been, and probably were, numbers of reptiles still on them. We turned over many rocks but without success. Both were distant from the land; they must have represented the remains of large hills. The other four unproductive islands were all small and sandy, from 10 to 40 ft. long, and not to exceed 6 ft. out of water. Two were already completely water-soaked.

The distribution of the lizards on the 13 remaining islands was as follows:

Species	Number of Islands
Uta stansburiana stejnegeri	8
Dipso-saurus dorsalis dorsalis	8
Sauromalus obesus	5
Cnemidophorus tessellatus tessellatus	5
Callisaurus ventralis ventralis	4
Crotaphytus collaris baileyi	2
Uta graciosa	1
Coleonyx variegatus	1

In actual numbers of specimens *Callisaurus* led, followed by *Uta s. stejnegeri, Cnemidophorus,* and *Dipso-saurus.* The maximum number of species of lizards on any one island was five; two islands had this number, one had four, and three others three each. The best islands were of moderate size, say 20 to 50 ft. long and 2 to 4 ft. out of the water, sandy but with some few rocks or pebbles for concealment. Most of the lizards seemed rather tame and were already thin from lack of food. Many, especially *Callisaurus* and *Dipso-saurus,* when frightened would rush right into the water, as if they did not recognize it as a different medium from land. Then some would sink helplessly, others would struggle back to shore.

On one small island, but a few square yards in area and only a foot or so out of water, 4 ravens were seen to land some 5 minutes before our arrival frightened them off. What they secured we had no means of knowing; we found a partly eaten *Sauromalus obesus,* but this was not fresh. They did not denude the island, for we secured 1 *Sauromalus,* 3 *Callisaurus,* and 2 *Coleonyx.* The last were in plain sight—nothing more defenseless could be imagined. The presence of these predators no doubt explains, at least in part, the disappearance of the rich fauna which must once have crowded the islands.

Aside from the lizards, which were much more plentiful than any other vertebrates, one island produced the only snake, a sidewinder, *Crotalus cerastes,* which was found under a rock. This was on a rather large rocky island, on which 5 species of lizards were also found. Another island, this one only about 20 ft. long and already quite water-soaked, disclosed a toad, *Bufo compactilis,* and two rats, the only amphibian and mammals found anywhere.

PARASITES

Although an occasional tick has been found on a large snake in the southwest, by far the most common ectoparasite of the lizards is a mite of a deep orange or vermilion color. It has occasionally been noted on snakes (*Diadophis* for example) but is far more prevalent on lizards, usually around the ears, on the shoulders, or under the arms or legs. It has been observed on the following species: *Phyllodactylus tuberculosus, Dipso-saurus dorsalis, Crotaphytus collaris, Crotaphytus wislizenii, Sauromalus obesus, Callisaurus ventralis, Uta stansburiana, Sceloporus occidentalis, Sceloporus graciosus, Sceloporus orcutti, Phrynosoma blainvillii, Phrynosoma platyrhinos, Gerrhonotus multi-carinatus, Xantusia henshawi, Cnemidophorus tessellatus,* and *Eumeces skiltonianus.*

The only internal parasites of lizards I have noted were round worms in the stomachs of specimens of *Phrynosoma m'callii, Sceloporus occidentalis bi-seriatus,* and *Crotaphytus wislizenii.*

MISCELLANEOUS NOTES ON SPECIES

We now proceed to the notes on individual species and subspecies:

Tubercular Gecko *Phyllodactylus tuberculosus* Wiegmann

This little lizard barely enters California, for it is principally a tropical form. It has been reported from the rocky foothills on the desert side of the mountains at Mountain Springs, Myers Creek Bridge (foot of Mountain Springs Grade), and Coyote Mountain, Imperial County; and Yaqui Well, Sentenac Canyon, Tubbs Spring, and One Thousand Palms Canyon, San Diego County. I have discovered no new way to capture it other than by the hard work of raising cap rocks or prying off heavy flakes. It is much less often found under thin flakes than *Xantusia henshawi,* for it seems to prefer a safer retreat. As noted on p. 33 these lizards may not be profitably hunted by driving at night, since they are only to be found where the road is bordered by masses of rock and only two have been collected in more than ten years by this method—both by Jas. Deuel. *Phyllodactylus* has an exceedingly fragile tail and great care must be used in catching it to seize it by the head or midbody. They squeak faintly when caught.

Western Gecko *Coleonyx variegatus* (Baird)

The habits of this exceedingly common nocturnal lizard have been treated at some length in the discussion of night collecting by driving (p. 34), for on the desert this is by far the easiest method of collecting this species. On the coastal side of the mountains it is still necessary to depend on over-turning rocks or debris to secure it. The coastal specimens, as far as my experience goes, are always small and marked with regular cross-bars. The desert specimens are barred, when young, but are usually blotched or spotted when fully grown. They reach a size considerably larger than those on the coast, specimens with a body length of 75 mm. and 150 mm. over-all having been collected. I have records of specimens taken under a variety of protective covers, including cap rocks, thin rock-flakes, yucca stems, boards, fallen advertising signs, and steer hides.

A captive *Coleonyx* was observed digging in the sand, alternately with front and hind feet. A shedding *Coleonyx* has been observed to detach and eat patches of the loosened skin; or other captives would remove the patches from their fellow. They are among the easiest of lizards to feed. William Derbonne has given an interesting report on *Coleonyx* in captivity (Copeia 1934, No. 4, p. 191).

While, in California east of the Sierras, this gecko has been recorded as far north as Owens Valley and Death Valley, Los Angeles County comprises the northwestern corner of its present known range. In that county it has been recorded at San Francisquito Plant No. 2 (5½ mi. air line N.W. of Castaic), Owensmouth, Vincent, and Lovejoy Springs. The last named point is the western limit of the Mohave desert range, but the first two comprise the northern known limit of the cismontane range.

DESERT CRESTED LIZARD *Dipso-saurus dorsalis dorsalis* (Baird and Girard)

These lizards are rather inquisitive and curious; they often stop in the road to observe an oncoming car with fatal results. It is their habit to perch on stones by the roadside for observation, holding the body off the rock with stiffened legs if it be hot. They also are seen to sit back and protect the tender parts of their feet by raising the toes. When pursued they take refuge in a nearby bush, from which they watch the intruder. If the pursuit continues they go down one of the mammal holes, always so plentiful around mesquite hummocks. They are very easy to collect, if one approaches the bush in which they are hiding slowly so that they can be seen before they are frightened into holing up.

I once found a *Dipso-saurus* impaled on a mesquite thorn. It was not seriously hurt and I think would have escaped in a short time; evidently it had just been caught in a frightened rush as it sighted me.

While *Dipso-saurus* is largely herbivorous it is not exclusively so. One was observed to eat ants and mealworms in captivity. On another occasion (May 12, 1929) I found a specimen with a piece of the skin of a *Uma notata* in one corner of his mouth. However this was not fresh and may have been picked up from the remains of a dead individual.

Dipso-saurus is at least as able to withstand high temperatures as any of our desert lizards, for it continues active on summer mornings as late as any lizards in this territory.

Van Denburgh has stated (Reptiles of Western North America, Vol. 1,

p. 76, 1922) that the easterly limit of the range of *Dipso-saurus* in Arizona is imperfectly known. Upon this I can offer some recent records, including: 3 mi. southeast of Picacho and 4 mi. north of Florence, Pinal County (the latter validates a record questioned by Van Denburgh); Hope, Salome, and Wenden, Yuma County; and 6 mi. south of Oatman and Willow Beach, Mohave County. Van Denburgh had already given the most easterly Maricopa County records: Phoenix, Tempe, and Cave Creek.

While on the subject of the range of this species, I think that a western Los Angeles County record which I once gave (Copeia No. 170, p. 16) should be suppressed. Although the identification was correct, as verified by Bogert (Bull. So. Cal. Acad. Sci., Vol. 29, p. 5), the locality is so decidedly out of the range of this species, both territorially and in character, that it should be viewed as a probable escape or a mix-up of specimens.

WESTERN COLLARD LIZARD *Crotaphytus collaris baileyi* Stejneger

This lizard is very common in certain of our southwestern areas, and some of the large brilliant green specimens are the most beautiful of our southwestern lizards. It seems particularly to favor rocky areas, and, where loose boulders have been scattered beside the right-of-way in clearing roads, it will be often observed perched on the rocks for observation. When frightened it takes refuge under the stones and is usually quite easy to capture, by a quick grab, as the stone is over-turned. Scattered rocks are preferred to territories which are essentially masses of rock.

Last June C. B. Perkins and I, hunting along the road from Paulden north to Ashfork, Arizona, found these lizards very plentiful. In one section many had their feet and tails heavily plastered with road oil. It was difficult to see how they could survive when so encrusted. It was not a recent acquisition, for the road and its shoulders were then quite dry. One had just eaten a *Sceloporus*.

When the rocks are hot, but still bearable, the perching collared lizard raises itself stiff-legged to avoid the heat conduction.

LEOPARD LIZARD *Crotaphytus wislizenii* Baird and Girard

Like *Dipso-saurus* this is an inquisitive lizard, often stopping in the road to observe an oncoming car.

It is well known that this species feeds largely on other lizards. Amongst those that I have found eaten have been *Uta stansburiana stejnegeri, U. graciosa,* and *Cnemidophorus tessellatus tessellatus.*

I have found females with the vermilion suffusion as early as May 7 and from then until June 1.

Coastal specimens are usually barred, and are darker than the blotched or spotted desert specimens.

C. wislizenii is a very fast lizard when it is really alarmed. One pursued in a lava field preferred to hide under rocks, rather than take refuge in the mammal holes which were present; however, on another occasion, one was dug out of just such a hole.

CHUCKWALLA *Sauromalus obesus* (Baird)

The chuckwalla, when alarmed, seeks refuge in a crevice in which he inflates himself and defies removal. The Indians are said to deflate these lizards by puncturing them with sharp sticks. Others who have tried this say it will not work. A more sporting method is to take a soft iron wire and thread it through the crevice in back of the chuck; then by sawing and pulling on the two ends he can usually be brought out. Another scheme, if his head can be reached with a stick, is to tap him repeatedly on the nose, whereupon he will accommodatingly back out. Don't make the mistake of seizing his tail or a leg until is fairly well out or he will quickly reverse his motion.

In captivity chuckwallas have a varied diet; amongst other things they will eat radish tops, lettuce, bananas, watermelon, cantaloupe, and grass.

The greatest concentration of chuckwallas I have seen was in the Black Mts., between Oatman and Goldroad, Mohave Co., Arizona. These were fine, large specimens, well suffused posteriorly with red.

While chuckwallas are usually rather tame, in twisting about endeavoring to escape they will occasionally slash with their tails. When annoyed they open their mouths and will sometimes try to bite.

FRINGE-FOOTED SAND LIZARD *Uma notata* Baird

This, the most highly specialized of our southwestern lizards, is widespread in the Mohave and Sonoran deserts wherever sandy areas, or even scattered sandy hummocks, are to be found.

There are various ways of catching *Uma notata* alive. Usually, when frightened, this lizard will run for a short distance and then dive into the sand, especially after placing a bush between himself and the hunter. Go to the other side of the bush and look for a patch of lizard hide, or a protruding tail, for sometimes they bury themselves carelessly. If this fails, use the fingers as a rake, but be ready to grab if you strike something, or the prey will be off again like a flash. Be careful that what you grab isn't a sidewinder.

A scheme for scaring up these lizards, when they are not running freely on the dunes, is to make use of a stick held flat against the dune surface, brushing rapidly across the sand at a depth of about an inch or more. In this way a considerable area can be disturbed with little effort. The shade of bushes, if any be present, is likely to be particularly fruitful, for these lizards seek shade when they burrow.

An interesting variant is to find a bush at the toe of a dune. Rake the sand with a stick. As the lizards emerge from the sand they will run up the slope, on which the sand is at its natural angle of repose. As they run up dig some sand away at the bottom, whereupon the sand of the entire surface of the slope will start cascading downward, flowing faster than the lizards can run or swim up, thus bringing them within reach.

When a *Uma* buries itself by swimming below the sand surface, he ends by trembling his tail, like a harmless snake in anger. This usually completes his concealment. On May 2, 1937, in the sand hills of Imperial County some 17 miles west of Yuma, Arizona, it was observed that, the surface of the sand being quite hot, when the lizards went in they buried themselves to a depth at which the sand was cool and comfortable. The point where a very large specimen dived in was noted. Then by probing he was found to be somewhat over 4 inches below the surface.

Sometimes in going after a single specimen in the sand below a bush, 3 or 4, whose presence has never been suspected, will emerge.

Sand lizards will perch on rocks for observation if there be any about. They will also climb up in bushes for the same purpose. They bob their heads in the manner characteristic of so many lizards. If not sure from what direction danger threatens, they will sometimes run in a small circle, stopping near the starting point.

Although favoring sand swimming as a means of escape, it has been noted that they do not scorn mammal holes, if any be at hand.

Uma is more compressed and flatter than *Callisaurus*. It reaches a length and weight considerably greater than any *Callisaurus* I have seen, specimens up to 235 mm. over-all (body length 115 mm.) having been noted. These large specimens are extremely wary.

Uma often seems to have a ground color closely matching the sand in which it lives. Thus the sand west of Yuma has a creamy tone, while that of Whitewater, near Palm Springs is grayish white, and the lizards show the same differences.

From the tracks left in the sand it is evident that *Uma* runs on its hind legs when going at full speed. However this is the only evidence we have; they move too rapidly for the eye to determine the exact posture. The scale fringes reach their greatest development on the fourth toe.

DESERT ZEBRA-TAILED LIZARD *Callisaurus ventralis** (Hallowell)

This is the most frequently seen lizard in the sandy or gravelly areas of our southwestern deserts; it does not entirely shun rocky places, but is probably most common on flats where a few small boulders may be scattered round about. On these it likes to perch for observation, raised up on stiffened legs when it is hot, and often bobbing its head up and down as if to clear its vision. Occasionally the males display their throat fans.

Callisaurus is an extremely speedy lizard, probably the fastest on the desert. It is practically impossible to follow it with the eye when it is alarmed and traveling across the line of sight. Usually it will stop just before taking refuge in a bush; sometimes, however, it will place a bush between itself and the pursuer before pausing to reconnoiter. When it stops it usually has the tail curled over the back and waving slowly from side to side; this renders the black bars on the underside particularly conspicuous. Then it is away again like a flash, the neutral gray streak of the disappearing lizard being so inconspicuous as to leave the eye anchored on the spot lately occupied by the swaying, brightly-marked tail. Whether the lizard actually runs at its highest speed with the tail curled over the back, and whether it uses only its hind legs, I am not sure, for this is very difficult to see. The statement, so often made, that it runs with the tail curled, may be the result of observations on lizards at rest or coming to a pause.

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*These notes are equally applicable to the subspecies *C. v. ventralis* and *C. v. gabbii.*

I once watched a *Callisaurus* chasing a *Uta stansburiana stejnegeri* near Topock, Arizona. They doubled and twisted here and there at high speed, like a dog chasing a rabbit. Unfortunately they were lost to sight behind some bushes, so that I failed to see the outcome of the pursuit.

Although *Callisaurus* is primarily a desert form, it is occasionally found far up on the precipitous and rocky eastern slope of the Peninsula Range. Thus I have observed it at Nightingale's in Riverside County, on the Palms to Pines Highway; and, in San Diego County, at Jacumba and west of Boulder Park. Further south, in Lower California, it filters through the mountain passes to the western slope, at Valle Trinidad and San José (Lat. 31°), for example.

Although *Callisaurus* is occasionally found abroad at night (p. 33), its activity is primarily diurnal—early in the morning in midsummer, at midday in the early spring.

The superficial resemblance of *Callisaurus ventralis ventralis* to *Holbrookia texana* is quite remarkable, especially having in mind the similarity of their habits.

GIANT ROCK UTA *Uta mearnsi* Stejneger

This interesting lizard has a very limited range in the United States, being found only on the eastern slope of the Peninsula Range, from the south side of the San Gorgonio Pass southward, in Riverside, San Diego, and Imperial counties, to the Mexican border. In Lower California it occurs as far south as the middle of the peninsula. It is restricted to the mountain slopes, where large boulders abound, or to rocky cliffs.

In late May specimens of *Uta mearnsi* were found exceedingly common in the great rocky ridge 4 mi. E. of Jacumba. They were most plentiful in the morning between 7 and 8, about 100 being seen within the hour. A secondary period of activity was noted between 4:30 and 5:30 P.M., but there were fewer than in the morning.

Uta mearnsi is quite inquisitive and consequently can be easily stalked. However it must be hard hit, for it will usually escape unless some of the fine shot take effect in the head. The ones that are so hit usually stick to the rock to which they were clinging. *Mearnsi* never seems to seek refuge in ground holes; always when pursued it jumps from rock to rock until a suitable crevice is found. In so doing it runs equally well on the tops or on the vertical sides of the boulders; and I have even seen one running on the underside of a boulder with the slope not more than 10° from horizontal. When not frightened it has a peculiar waddling gait.

LONG-TAILED BRUSH LIZARD *Uta graciosa* (Hallowell)

Uta graciosa has a marvelous power of color change, being able to vary from a very dark slate-gray to a light cream. The latter color will be noted after a specimen has been kept for a short time in a white muslin bag.

These lizards are usually found on the stems of desert shrubs, particularly greasewood. Here they hang head downward, the gray of their bodies so closely matching the stems to which they cling, that they are discovered with difficulty. However, if one uses patience, and, while standing from 6 to 10 feet from a bush, concentrates on one stem at a time and scans it carefully from bottom to top, the lizards will be disclosed, sometimes two or three to a bush. Occasionally they go around a stem to keep it between themselves and the intruder, in the manner of a squirrel. If one approaches too closely to the bush, they run quickly down the stem and take refuge in the holes always present at the base. C. M. Bogert states that this *Uta* can be taken at night by shining a flashlight along each stem, being disclosed by the reflection of the light on the white of their bellies. He tried this with great success at Boulder City, Nev.

SMALL-SCALED UTA *Uta microscutata* Van Denburgh

This is the smallest lizard of this genus to be found in the southwest. Dorsally it is black or dark gray. Below, the males are blue. In California they have orange throats with a yellow-spot in the center, but at the southern limit of the range in Lower California the males' throats are usually blue.

Uta microscutata is essentially a rock dweller, where it partly, but not entirely, replaces the omnipresent *Uta stansburiana*. When frightened it usually seeks refuge in ground holes. While most prevalent on the desert slope of the mountains of San Diego County, it has been found on the coastal side, at such points as Cottonwood and Deerhorn Flat. Further south in Lower California it is more plentiful on the coastal side of the mountains; I found it rather common at such places as Ojos Negros and Rio de las Flores. As far as I know Borego Palm Canyon, San Diego County, is the most northerly point where this species has been observed in the United States.

ARIZONA ROCK UTA *Uta ornata symmetrica* Baird

Although I have most often found this lizard in rocky places, where it seeks refuge in crevices, it has also been observed in shrubs and trees. Thus at Willow Beach, on the east bank of the Colorado River in Mohave County, Arizona, it was plentiful in the branches of the mesquite and willow trees along the shore. The blue ventral color of the males is exceedingly brilliant and beautiful in life.

DESERT SIDE-BLOTCH LIZARD *Uta stanburiana stejnegeri* Schmidt

This desert lizard, together with its coastal counterpart, the California Side-blotch Lizard *Uta stansburiana hesperis* Richardson, is probably the most widespread of all our southwestern species, since it is found from the

Lower Sonoran to the Transition Zone. No other form has so extreme an ecological range, *Cnemidophorus tessellatus* being its only close competitor in this particular. But while the whiptail is found almost as high in the mountains as the uta, it is rare or absent in the coastal area, where the uta is present, even to the sands of the seashore. Everywhere it is common, amid trees, chaparral, grass, in rocky or sandy deserts; and usually, but not always, it is the commonest lizard in each of these habitats. It is not particularly wary and is not speedy, compared with many of the larger species. It usually takes refuge in ground holes. L. H. Cook informs me they will burrow in sand when the sand in turn is covered by a board.

WESTERN FENCE LIZARD *Sceloporus occidentalis bi-seriatus* Hallowell

A few field notes on this very common coastal and mountain lizard:

April 25, 1925. Found one under a log at Cuyamaca Lake. It was cold and almost stiff, but quickly became lively when warmed.

July 11, 1928. Noted stomach worms in a specimen from Cottonwood, and another from Laguna Mt. with vermilion mites.

June 25, 1933. A specimen shot blood from the eyes, somewhat after the manner of *Phrynosoma*, when the neck was slightly squeezed by a thread loop.

July 23, 1933. Active at 6:45 P.M.

March 27, 1936. Saw a lizard, apparently of this species, carried by a sparrow hawk.

SOUTHERN MOUNTAIN SWIFT *Sceloporus graciosus vandenburgianus* Cope

This is a mountain form, in southern California probably attaining its greatest abundance in the belt between 5,000 and 6,000 ft. altitude. Here it is very plentiful, far exceeding all other lizards. It reaches an altitude of at least 9,000 ft., but is progressively less common above 6,000 ft. As it rarely, if ever, descends below 4,000 ft., the southern California range is broken up into a series of montane islands.

These lizards are found perched on logs, stumps, or rocks. When frightened they generally take refuge under logs, but do not scorn, as hiding places, stones, ground holes, or even pine needles, leaves, or other debris. They occasionally run up trees. They are quick and difficult to catch, unless they can be driven into grass, where they become entangled so that one can easily secure them.

DESERT SCALY LIZARD *Sceloporus magister magister* Hallowell

I have found this lizard amongst cottonwood trees, willows, mesquite, small shrubs, joshua trees, and, less often, amid rocks. If one is hunting for *Xantusia vigilis* under fallen yuccas, a scaly lizard will be occasionally discovered, particularly if it be a cold day. At Rockville, Utah, they were observed high above ground in large cottonwoods. Near Wadsworth, Nevada, they were in bushes amid sand dunes and only a few feet above ground. This species is more inquisitive and less wary than S. *orcutti*.

GRANITE SCALY LIZARD *Sceloporus orcutti* Stejneger

The late C. R. Orcutt told me that the type locality of this species (Milquatay Valley) is one of the large piles of granite boulders a few hundred yards east of the present town of Campo, San Diego County. Here he found several specimens chilled by a sudden flurry of snow. Since this designation is now seldom used for the Campo Valley, the modern geographer might confuse this locality with the hamlet of Guatay at the foot of Guatay Mt., near Descanso.

The granite scaly lizard is very common in rocky areas on both sides of the mountains, from San Gorgonio Pass south; a few specimens have been reported north of the San Bernardino plain. It is so wary that it is very difficult to catch, and is not even easy to shoot. Occasionally it takes refuge in crevices, instead of under the rocks, in which case it can be fished out with a snare.

One habitat where this lizard exceeds all others in numbers is in the mounds of granite which dot the valleys of Riverside County, between the Santa Ana and Elsinore Mountains, on the west, and the San Jacintos on the east. Here they are very plentiful, especially in spring. At Perris, a specimen was noted active at 7:15 A.M. One was observed in a tree at Glen Lonely, San Diego County, several hundred feet from granite.

ARIZONA SHORT-HORNED HORNED TOAD *Phrynosoma orbiculare hernandesi* (Girard)

On August 1, 1931, I received from C. M. Bogert a specimen of this subspecies, collected at the base of Mt. Elden, Coconino Co., Arizona. It had given birth to 27 young en route. The newly born young run with short quick dashes. They try, rather ineffectually, to bury themselves in the sand. I am advised that full grown specimens in captivity have been observed to eat some of these tiny youngsters. Very large and beautifully colored specimens of this form are found in north-central Arizona.

Lately I had occasion to examine a series of short-horned horned toads from both sides of the U. S.-Mexican border. Hitherto it seems to have been the practice to segregate these into two species, somewhat on geographical grounds, those from the north of the border being referred to one of the several subspecies of *douglassii,* while those from Mexico have been considered *orbiculare.* I am unable to find any consistent difference between the two groups and it is therefore my opinion that all of these short-horned horned toads should be considered subspecies of *orbiculare,* this being the older name. The situation is somewhat complicated by the fact that in the middle of the range of this group the horned toads are restricted to the higher altitudes, and therefore the range comprises a scattered series of montane islands of varying extent. In these islands differentiation has taken place to some small degree, and consequently there is a considerable dispersion in various characters among these specimens. Further north in the Great Basin, and to the south in the Mexican Plateau, the populations are continuous and seem more consistent.

Of course there is a very wide difference between the most northerly race, *douglassii,* and the southernmost form, *boucardii;* but, if we survey the entire group, each character is found gradually to undergo modification between the two extremes with what seems to be a geographical consistency. Some of these differences and their trends are as follows:

In the northern specimens the nostrils are on the side of the head and face outward; they are usually, but not always, below the extension of the canthus rostralis—often there is an actual ridge above them. The plane represented by the edge of the aperture is substantially vertical. As we study specimens from further southward we find the nostrils more nearly in the line of the canthus rostralis or above, and the plane of the edges diverges from the vertical. The nostrils tend to face forward or upward, rather than sideways, as in the extreme northern individuals; thus they appear larger from the front. Actually, however, they are only slightly larger in specimens of similar size. The canthal ridge itself is in evidence further forward in the northern than the southern specimens.

The posterior horns of the head (both the occipitals and temporals) are much more prominent in the southern than in the northern subspecies. This is probably the most pronounced difference between the two extremes, yet if one has a series fairly representative of all latitudes the change will be seen to be gradual rather than by a sudden step. The temporal shelf is not so pronounced in the southern forms, and therefore the temporals do not extend out beyond the occipitals in the southern forms to the degree that they do in the north. There seems to be nothing definite or geographically consistent in the direction in which these spines point.

The posterior members of the infralabial series of spines are somewhat larger and more pointed in the southern specimens.

The enlarged preaurals are much more conspicuous in the northern specimens; they are absent entirely in some of those from the south, but are present, although reduced, in others. They are absent in some Arizona specimens. The enlarged postaurals are largest in the southern specimens, and reach a maximum posteriorly; while as we go northward they tend to reach their largest size in the middle of the series.

The posterior gulars are more pointed in the southerly specimens and more tubercular in the northern.

With quite a full series of specimens available from Mexico City to eastern Washington, all of these changes are gradual, so that no key character seems to separate one group from the other, either at the international boundary or elsewhere. Therefore I conclude that but one species should be recognized, with the following subspecies:

Phrynosoma orbiculare orbiculare (Linné), 1758.
P. o. boucardii (A. Duméril and Bocourt), 1870.
P. o. cortezii (A. Duméril and Bocourt), 1870.
P. o. dugesii (A. Duméril and Bocourt), 1870.
P. o. hernandesi (Girard), 1858.

P. o. ornatissimum (Girard), 1858.
P. o. ornatum (Girard), 1858.
P. o. brevirostre (Girard), 1858.
P. o. douglassii (Bell), 1833.

Several of these subspecies are weakly differentiated, and of doubtful validity. A thorough study and revision is badly needed.

SAN DIEGO HORNED TOAD *Phrynosoma blainvillii blainvillii* Gray

I have never been able to determine in advance when one of these horned toads will eject blood from its eyes, nor to correlate the result with sex, season, temperature, or any other factor. Sometimes they will; more often they won't, but I can't tell which it is to be. I think that horned toads are naturally so gentle and tame that, unless they will spit when first captured, they will seldom do it later. To get them to go into action we usually scratch the sides of their heads or the lateral edges of the body (not necessarily with roughness). Often this will cause the eyes to swell, but without the final ejecting of blood, which result is secured much less frequently.

There is some evidence that a dog can precipitate a stream of blood when other means fail; at least this has worked on two recent occasions. Many years ago, when horned toads were much more common hereabouts than now, we owned a white bull terrier. Whenever he came home with his forehead spattered with blood we knew he had been nosing a horned toad. And although he would tackle anything on four legs (he had two bob-cats to his credit), if my memory serves me correctly, he let the horned toads go their ways. Maybe they were beneath his notice; maybe there is here indicated a partial protection against the coyote. At least, a sudden fine stream of blood in the eyes is rather disconcerting.

Frank F. Gander tells me that his house cat slightly injured a horned toad of this species. The horned toad retaliated with a spray of blood in the cat's face. The cat showed signs of considerable discomfort; it rolled over and brushed its head violently with its paws and frothed at the mouth. This lasted but a short time; however the cat was observed to avoid horned toads thereafter when they were brought in the house.

I remember that some 50 years ago we children were amazed at the repeated rediscovery by scientists that the blood-spitting horned toad was no myth.* This was old stuff to us, for the horned toad was our best-known reptile; it made the best pet, and there was a fairly good sale for them at 10 cents each. Maybe I only remember the times when the market wasn't glutted. At any rate in those days no eastern tourist was supposed to return without one of these creatures stuffed and fastened on a thin, diagonal section of an orange tree trunk. In the highly varnished results (they varnished both the wood and the animal) our early commercial taxidermists reached a new low in nature groups.

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* Hay, O. P. On the Ejection of Blood from the Eyes of Horned Toads. Proc. U.S.N.M., Vol. 15, pp. 375-378, 1892.

On May 10, 1935, I noted an unusually large specimen of *P. b. blainvillii* at Del Dios, San Diego County; a male, length 161 mm., maximum width 64 mm. He had lately ejected blood, as shown by the spots on his head, but he would not again, although his eyes swelled when sniffed at by a dog. On another occasion (Bonsall, June 5, 1937) a specimen ejected blood from the left eye, but not the right.

Blood ejection is not the only means of defense which these lizards have. Occasionally when one is angered he will wriggle and twist about with his head in an endeavor to use his horns on the hand which holds him. They also open their mouths and hiss when annoyed, and often will jump toward the person who disturbs them. When they bite they hold on, but the resulting pinch is not particularly severe. Frank F. Gander reports that on two occasions males of this species have jumped at his foot and have bitten the sole of his shoe.

The horned toads in coastal San Diego County appear to have a very short season of intensive activity. This is in the spring from about April 15 to May 15. At this time—at least in primitive areas—they are quite common. This was the case, for example, in the Ojos Negros Valley of Lower California on May 5, 1935. Here, in the morning, one crossed the road in front of the car every hundred yards or so. They seemed to be as plentiful as any lizard there. But at other seasons, even in the cool coastal belt, they appear to be very scarce.

This species occasionally perches on rocks for observation or to sun themselves. When the intruder approaches closely they run under the rock or into the nearest bush.

While horned toads do not have separable tails like so many lizards, I have found two specimens with tails partly cut off.

This species has a considerable power of color change, and seem often to match the color of the soil or sand on which they are found.

TEXAS HORNED TOAD *Phrynosoma cornutum* (Harlan)

I caught a specimen on U. S. 80, 9 mi. W. of Benson, Arizona, just east of the Pima-Cochise County line. This must be near the western limit of the range of this species.

DESERT HORNED TOAD *Phrynosoma platyrhinos platyrhinos* Girard

This species is very common in some areas of the desert early in the spring. For example on April 19, 1930, a clear, hot day, in the early afternoon they were very plentiful along the old road from Ryan to Shoshone, on the mesa east of Death Valley, mostly perched on scattered rocks by the roadside. Although the weather was a little too warm for our comfort, the horned toads were on the sunny sides of the rocks. When approached they would duck their heads, as if to dodge a blow, but seldom attempted to run away. Again on April 14, 1936, another hot day, numbers were seen on the rocks along the highway on the east slope of the Panamint Mountains, from Stovepipe Wells toward Towne's Pass. This was at noon. They were more plentiful at the higher elevations than below.

This is the most widespread and common horned toad of our southwestern deserts, the only other truly desert form being *P. m'callii*. Other horned toads, such as *P. solare*, *P. cornutum*, *P. o. hernandesi*, and *P. b. frontale*, range into the desert from their centers of distribution, but stop short of such extreme areas as Death Valley, and the Colorado and Yuma deserts. Probably of these forms *P. solare* is to be considered most nearly desert in habitat. It is the common horned toad of the Phoenix and Tucson areas.

I have seen horned toads of this species out until half an hour after sunset, but they do not seem to become nocturnal to any degree in summer.

FLAT-TAILED HORNED TOAD *Phrynosoma m'callii* (Hallowell)

To the localities given in Copeia, 1932, p. 100, I am able to add the following: La Quinta (Riverside County); Rancho de Anza or Beatty's in Borego Valley, Benson's Dry Lake, Carrizo Spring (San Diego County); Signal Mt., Kane Spring, Harper's Well, Gray's Well, Sand Hills Maintenance Station, and 20 miles east of Holtville (Imperial County).

F. E. Benson of Benson's Dry Lake (or Ocotillo) on the Julian-Kane Springs road at the eastern edge of San Diego County, where these lizards are rather common, tells me that he has seen only one out at night, this being at 8 o'clock. It may be noted that at this locality, a sandy, gravelly, desert flat, *P. m'callii* is more plentiful than *P. p. platyrhinos*, which is not true in most of the desert areas where the two are found together, and is contrary to what I had previously reported. *P. m'callii* occupies a much more restricted area, both territorially and ecologically, in the southwest than *platyrhinos*.

I have found this species most plentiful in mid-morning in late April and the first week of May. Like many species of horned toads, they usually spend the night just below the surface of the sand. They cover themselves by violent wriggles, without going forward. While tame, like all the horned toads, the horns of its head are so sharp that it can pierce the skin as it wriggles trying to escape. The stomach of a specimen from Harper's Well contained nematodes.

SOUTHERN CALIFORNIA ALLIGATOR LIZARD *Gerrhonotus multi-carinatus webbii* Baird

A few notes: July 17, 1927 observed a small individual on the side of a rock (hunting?) at dusk. The young are quite different in color from the adults; they are unicolor bronze, while the adults are banded and blotched with red, orange, or brown, on a gray background.

August 19, 1928, noted that specimens from South Coronado Island (the subspecies *G. m. nanus*) are heavily infested with vermilion mites.

May 17, 1929, a specimen from Deerhorn Flat had 3 large black ticks.

March 30, 1934, a pair was seen mating.

This species is rather common about San Diego gardens and garages. Cats seem to be their worst enemies. They are active early in the spring. as would be expected of a species largely Upper Sonoran or Transition in habitat. They swim well, having been noted in streams, irrigation ditches, and conduits.

CALIFORNIA LEGLESS LIZARD *Anniella pulchra* Gray

Thus far I have never found a DOR *Anniella,* although Samuel Harter reported one from Mission Valley. At any rate it travels above ground less frequently than *Leptotyphlops humilis.* The latter is found rather commonly, either alive or dead, on the Borego road between the top of Sentenac Canyon and the Narrows. *Anniella* is also present here, as shown by specimens found under rocks and plant debris, but I know of none found above ground.

L. H. Cook tells me that, in looking for the legless lizards under boards or rubbish on a sandy beach, one should not expect to find them between the sand surface and the wooden cover. Rather they will be found an inch or more under the sand, but still under the protection of the timber, so that they are best secured by raking the sand.

An embryo *Anniella* was removed from an adult collected at Pacific Beach, San Diego County, Nov. 10, 1938. It was evidently more mature that the two previously described (Notes on the Silvery Footless Lizard *Anniella pulchra,* Copeia, 1932, pp. 4-6) as the length over-all was 97 mm., body length 63 mm. The length of the mother was 142 mm., body length 109 mm., tail incomplete. In the present embryo the similarities to *A. nigra* are more marked than the other two. The sides and ventral surface of the head are quite black; and all of the longitudinal lines, both the three primaries, and the secondaries (especially anteriorly), are much more prominent than in the adults of *pulchra.* The ground color is gray rather than cream. However there is one area wherein the increased pigmentation of the embryo is not like the pattern of *nigra;* this is in the longitudinal lines on the belly, for the ventral surface, posterior to the dark bib on the neck, is actually lighter and clearer in *nigra* than in *pulchra.*

GRANITE NIGHT LIZARD *Xantusia henshawi* Stejneger

The method of catching this lizard by prying off granite flakes has been described in some detail in a previous paper (Field Notes on *Xantusia henshawi,* Copeia, 1926, No. 152, pp. 115-117). This scheme has not been improved on. Few specimens have been caught in the open at night; they are difficult to see amongst the granite, and they are rarely observed on the road, as they do not stray far from their rocky haunts.

A few field notes follow: April 19, 1925, at Wildwood, 4 specimens were found under a single flake. As is usual in the early spring they were under flakes on the south faces of boulders.

July 12, 1925, at Dulzura, they were often under chunks of considerable thickness, rather than flakes, the result, no doubt, of the warmer weather.

April 16, 1927, at Shady Dell, a dead specimen was found in the open in daylight. It had choked to death on a grub.

June 5, 1927. Specimens with vermilion mites were noted at Dulzura. Also on April 21, 1928.

June 2, 1928. Hunted in an area burned over the previous year. Fourteen specimens of *Xantusia henshawi* were collected and an equal number lost. Contrary to the usual situation they were much more plentiful than *Uta stansburiana hesperis* or *Sceloporus occidentalis bi-seriatus,* of which only one of each was noted. Evidently *Xantusia* can find security in deep rock crevices when fire rages through the chaparral.

July 15, 1932. A specimen was found in a house near Barrett Dam.

April 16, 1933, at Valentine, Riverside County, one was found deep in the crack of a very large boulder. It was quite cold and dormant.

May 11, 1933. On the Palms to Pines Highway, Riverside County, some ten miles south of the road junction at Date Gardens, I found *X. henshawi* and *X. vigilis* within a few feet of each other, as usual in their preferred habitats of granite and yuccas respectively. On the same road I found *X. henshawi* at an altitude of 4,500 ft., the highest record I have had from southern California. In Lower California they have been collected at 7,300 ft.

I have previously given a sufficient number of localities where *X. henshawi* has been collected in San Diego County (Trans. S. D. Soc. Nat. Hist., 1931, Vol. 7, No. 1, p. 10). However at that time the range in Riverside County was less perfectly known than at present, the new localities showing it to occur as far north as the south side of San Gorgonio Pass. The Riverside County localities known to me are as follows: Baliff Ranch near Cabazon, Snow Creek, Vandeventer Flats, Junction of Grapevine and Indian Creeks, 1 mi. NE. of Black Hill, Ribbonwood, Nightingales, 2 mi. E. of Piñon Flat, Cahuilla, and Aguanga. There are also several new localities from extreme northern Lower California: Laguna Hansen, Palo Gacho, and 8 mi. E. of Valentín.

Yucca Night Lizard *Xantusia vigilis* Baird

Xantusia vigilis is to be found under fallen and disintegrating yucca stems, whether of the Joshua Tree (*Yucca brevifolia*) or the Spanish Dagger (*Yucca mohavensis*). An old fashioned hayhook is the best tool to use for overturning these stems, sheathed as they are with sharply pointed leaves, which, without such a tool, are very painful to the hands. The hunter should be set to grab the quarry before overturning the stem; for the lizards, although light-struck at first, quickly wiggle under other stems or debris. A handful of soft muslin in one hand, as the other wields the hook, is excellent for covering and pinioning the prey. Once a lizard is held down with the soft pad, it is easy to roll it slowly back until the head or a leg is disclosed, thus permitting a capture without breakage of the fragile tail. The muslin variant is due to Mr. C. B. Perkins.

Xantusia vigilis is so small and dark that its capture at night would be most unusual. Although this lizard is very common in some areas, I have never noted one at night while driving on yucca-bordered roads.

The northeastern range limit of this species, as far as known at present, will be indicated by the following Arizona and Nevada records: 2 mi. W. of Hancock, 6 mi. E. of Goldroad, Union, 26 mi. NW. of Chloride (on the Boulder Dam Road), and 4 mi. SE. of Hoover Mine (Mohave County, Arizona); Jean, Erie, Sloan, N. end of Piute Mts., Piute Valley SW. of Searchlight, 25 mi. NW. of Las Vegas on road to Indian Springs, and Pahrump Valley (Clark County, Nevada). I have looked for it in extreme southwestern Utah without success.

The greatest altitude at which I have collected this species is Walker Pass, northeastern Kern County, California. The pass is 5,248 ft. The lizards are plentiful a little below the summit on the lee (east) side. It is a windy and desolate area. I also found them 4 mi. E. of Onyx, Kern County. Another high point is Mountain Pass, on U.S. 91 in San Bernardino County, just west of the Nevada line; the altitude is 5,190 ft.

Through the courtesy of Harold Woodall I have seen specimens of *X. vigilis* from Santa Catalina Island. It is thought that they are probably not native to the island but were introduced in connection with the transplanting of cacti, yuccas, or other plants from the desert.

While *X. vigilis* is usually under yucca stems, they are occasionally found in other places of concealment, especially under dead bushes, or roots. I found one under a fallen sign, and another under waste paper. At Deadman's Point, near Victorville, San Bernardino County, four specimens were found under granite flakes, just as *X. henshawi* occurs in its habitat further south.

It is best not to hunt *X. vigilis* when it is too warm, for they will then be very active and difficult to catch when uncovered. In cool weather they are more torpid, and when light-struck, will give the hunter a better chance to secure them. We have made good catches as early as February and March. They should not be hunted at dusk, as they will not be light-struck and will run at once.

Where both Joshua trees (*Yucca brevifolia*) and Spanish Daggers (*Yucca mohavensis*) are present in the same area, the latter seems to be the preferred habitat, although there will usually be fewer dead branches of these available to turn over. At any rate we now know that we need not restrict our searches to areas where *Y. brevifolia* occurs. Well rotted debris, adhering closely to the ground, is more often found to harbor lizards than recently fallen branches or stems. The leaves need not be retained. Possibly there may be some additional warmth in the rotting debris, or the lizards may be attracted by the termites frequently found under the same stems.

The tails of these little lizards are broken off at the slightest touch; they squirm with great violence for some moments when disjointed.

DESERT WHIPTAIL LIZARD *Cnemidophorus tessellatus tessellatus* (Say)

These speedy lizards are exceedingly common in many areas in the southwest. They are easy to shoot as, when frightened, they usually rush toward a bush, but stop short of entering it, and then advance with the slow, jerky motion which is so characteristic of their movements when unalarmed.

There is hardly any type of habitat in the southwest where they are not found. While they do not seem to inhabit masses of rock they will be present as long as there are some sandy spots between.

The coastal-foothill subspecies, *C. t. stejnegeri*, even ascends to the Transition Zone, at least to 5,000 ft. or above. Yet here it is observed to show the effect of its desert origin, for it comes out later in the season than most of the reptiles of the area and remains more active during the hot summer. Thus at White Eagle, Campo, and Descanso, San Diego County, I have seen this subspecies active amongst the chaparral at noon on warm days when all other lizards had sought their cool retreats.

Although whiptails can stand a mountain climate, they are rare or absent along the coast, where the cool and overcast days of summer seem not to their liking. In this they differ from their relative, the California Orange Throated Lizard *Cnemidophorus hyperythrus beldingi,* which is found along the coast and thence back to the foot of the mountains. However the latter species does not cross to the desert side of the mountains, so that it is much more restricted in habitat than the whiptail.

At Leeds, Utah, a *C. t. tessellatus* did not hesitate to jump into a small creek to escape capture; he swam across without difficulty.

Near Tucson a specimen was observed with the wings of a cicada protruding from his mouth. They have been observed feeding on grasshoppers. In captivity they are said to eat almost anything in the way of an insect.

One individual was seen on a road bordered by alfalfa fields, from which we judge they are not completely driven out by irrigation.

WESTERN SKINK *Eumeces skiltonianus skiltonianus* Baird and Girard

Since Dr. E. H. Taylor has described the Red-tailed skink *Eumeces gilberti rubricaudatus** and we find ourselves with two skinks in San Diego County, where but one was presumed to be present before, we are under the necessity of devising means of differentiating the two at all stages of growth. While there appears to be no doubt as to the accuracy of Taylor's conclusion respecting the composite character of the specimens which we once allocated to a single species (*skiltonianus*), the fact remains that they are not always easy to distinguish at certain transition pattern stages during growth, particularly when complicated by the fading, or color change, incident to preservation.

In the juvenile state they may be easily distinguished, for *E. s. skiltonianus* has a bright blue tail, while that of *E. g. rubricaudatus* is salmon or pink. Also when fully grown *rubricaudatus* reaches a size beyond that of *skiltonianus*, and loses all its stripes, becoming unicolor olive, whereas *skiltonianus* always retains its stripes. But it is difficult to diagnose *rubricaudatus* by any simple characteristic of color or pattern, between the juvenile state and ultimate adult size; or *skiltonianus*, after it has lost its blue tail. For, when the blue color is gone, the tail is often lavender or pinkish and little different from a half grown *rubricaudatus*.

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* A Taxonomic Study of the Cosmopolitan Scincoid Lizards of the Genus *Eumeces* Kans. Univ. Sci. Bull., 1935, Vol. 23, p. 446.

Taking, as samples, those specimens of which the color, or pattern, make the diagnosis simple, I first checked the following differences in scalation given by Taylor:

	Skiltonianus	*Rubricaudatus*
Supralabials	Usually 7	Usually 8
Interparietal	Usually enclosed by parietals	Usually unenclosed

I found among San Diego County specimens the first difference to be maintained with considerable consistence, but the second was not. However there is another difference in the interparietal which is quite consistent and will solve most questionable cases, particularly if a few specimens already diagnosed by color are available for comparison: in *skiltonianus* the interparietal is sharply wedge-shaped, while it is more blunt in *rubricaudatus*, the sides tending more toward parallelism.